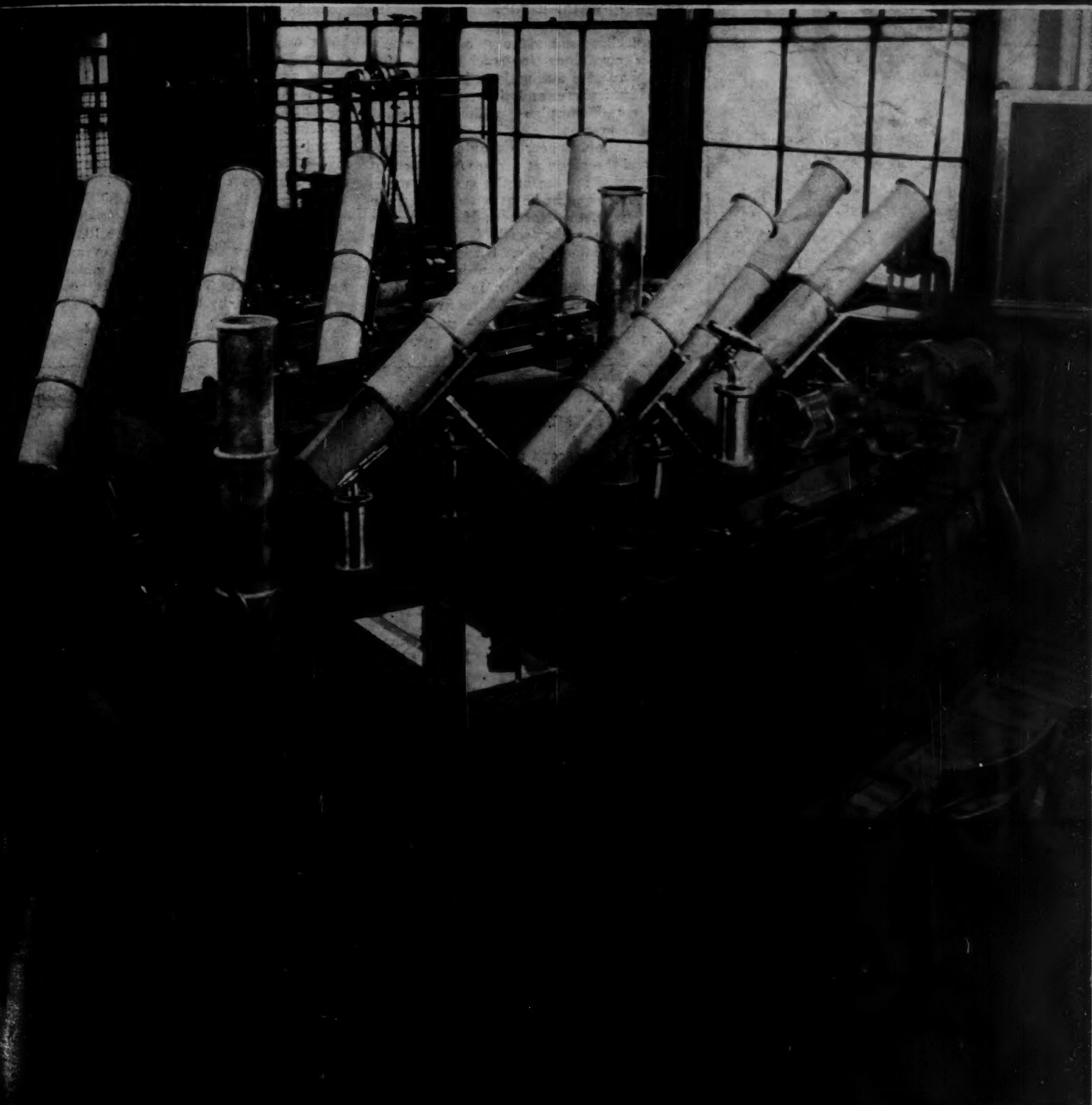

Sky and TELESCOPE

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SKY PUBLISHING CORPORATION

CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

LETTERS

Sir:

Mr. Oravec's fine treatment of the subject of the visibility of the moon in the August issue leaves little to be added. Careful observation near the time of new moon, which would make the moon visible every day in the month, is especially interesting. The two reasons stated (maximum declination and length of day) would render conditions for such observation most favorable during June in the Northern Hemisphere and December in the Southern Hemisphere within the same calendar year.

In addition, the earth should be at aphelion and the moon at perigee in order that the relative motion of the sun and moon in right ascension be at a maximum. In this respect, the Northern Hemisphere is favored since the earth is at aphelion about the 1st of July. During 1950 and 1951, however, new moon in June will occur near apogee, while in December it will be close to perigee. After five periods of regression of the moon's nodes, with 10.5 revolutions of the line of apsides — an interval of 93 years — there will occur a new moon in June at the time of maximum northerly declination and perigee.

I wish also to call attention to the inconsistency of nomenclature found in **Sky and Telescope** and in **Popular Astronomy** when referring to the meteor shower of October 9-10, 1946, as the Giacobinids. It is suggested that they be called the Draconids, with the prefixing of the Greek letter of the star nearest the radiant (as in the Delta Aquarids) if there is a previous shower with that designation. If this is not done, then the Eta Aquarids and the Orionids should be called the Halleids. Besides, the name Giacobinids is not fair to Mr. Zinner, whose name is also associated with the comet from which those meteors emanate.

PAUL STEVENS
2322 Westfall Road
Rochester 10, N. Y.

Ed. Note: We agree with Mr. Stevens that the names of meteor showers ought to be standardized. The problem is complicated, however, by the discovery of showers by radar.

(Continued on page 35)

VOL. VII, NO. 2
WHOLE NUMBER 74

DECEMBER, 1947

CONTENTS

COVER: Telescope mountings in the process of construction in the science shop of Stuyvesant High School, New York City. The work was done under the leadership of Harvey E. Parry. Thirteen amateurs constructed mountings by mass-production techniques, to be used with mirrors completed at the Hayden Planetarium in classes conducted by the Optical Division of the Amateur Astronomers Association. Photograph by Anderson, Stuyvesant High School Photography Club. (See page 47.)

BACK COVER: A Harvard Observatory photograph of the region of the southern Coalsack, with the star Alpha Crucis at the top of the field. (See In Focus.)

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THE MOTION OF MERCURY

By G. M. Clemence, Director Nautical Almanac, *U. S. Naval Observatory*

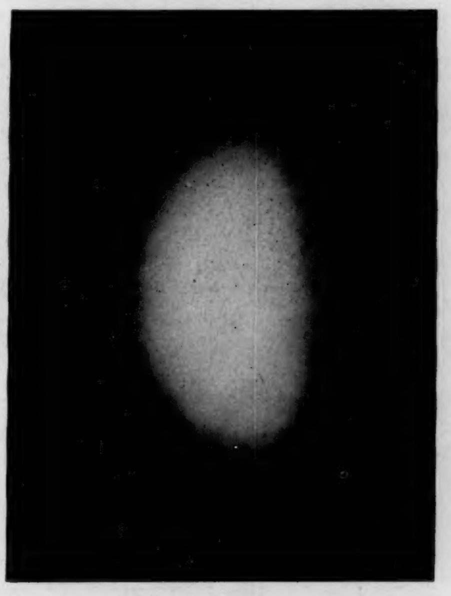
TO THE STUDENT of motions in the solar system Mercury is of special interest. It is the nearest to the sun of all the planets and the most quickly moving, completing a circuit around the sun in less than three months. It is the least massive of the nine major planets. The mass is known with low accuracy, but it is approximately 1/20 that of the earth, or four times that of the moon. It is not this characteristic that is of particular interest, however; perhaps the most interesting fact about the planet is that it furnishes the most accurate observational confirmation of the theory of general relativity, which asserts that the elliptical orbit of any planet rotates slowly in space at a slightly different speed from that given by Newton's law of gravitation.

To get a clear picture of the problem, and of the accuracy of the measurements involved, it is useful to make a scale drawing of Mercury's orbit, its path around the sun. Draw a circle five inches in diameter, and draw any diameter of the circle. Although the orbit of Mercury is not really a circle but an ellipse, the deviation from a circle is hardly noticeable on this scale. Place the sun on the diameter of the circle, ½ inch from the center; it should be a dot about 1/16 inch in diameter. The point where the diameter intersects the circle nearer to the sun is the ***perihelion*** of Mercury. This Greek word means "near the sun." On the same scale the orbit of the earth may be represented by a circle 13 inches in diameter with center at the sun.

The orbit of Mercury is not stationary in space but is slowly rotating, which causes the perihelion to revolve slowly around the sun. Measure off along the orbit from the perihelion a distance of 1/100 inch. This is the amount of motion of the perihelion during the past 180 years, that is, since accurate observations of Mercury were commenced. This motion is due to two causes, one of which was known long before Einstein formulated the theory of relativity. The motion is the effect of the gravitational influence of all the other planets, accounting for about 92 per cent of the total motion. The remaining eight per cent, or about 1/1,000 inch on the diagram, is due to relativity. It is remarkable that this small quantity can be detected at all, but it has actually been measured with an accuracy of 1/50 of its amount, or 1/50,000 inch on the diagram. This feat is all the more remarkable when the peculiar difficulties of observation are considered.

In the first place the perihelion is not a visible point in the sky, whose motion among the stars can be directly measured. Instead, the position of the perihelion has to be deduced by observing the position of Mercury itself; the perihelion is the point of the orbit where Mercury is moving most rapidly. Therefore, numerous observations of Mercury's right ascension and declination must be made, the motion of the planet deduced from these, and the position of the perihelion found from the deduced motion of the planet.

Another difficulty is that the observer has to stand on the earth, which is a poor observing platform to use for this purpose; the sun would be much better. From the earth the orbit of Mercury is seen nearly edge on, with the sun in the middle. The planet never gets very far away from the sun in the sky, and it has to be observed when it is on the meridian, which is always in the daytime, usually between 11:00 a.m. and 1:00 p.m., under about the worst observing conditions imaginable. The image is not well defined, but looks like a dancing faint blur of light. When the planet is best seen, that is, when it appears farthest from the sun, it is not moving across the line of sight but nearly along it, and therefore the observation gives but a weak hold on the planet's real motion, just as the speed of a receding railroad train can be only poorly determined by standing in the middle of the track.



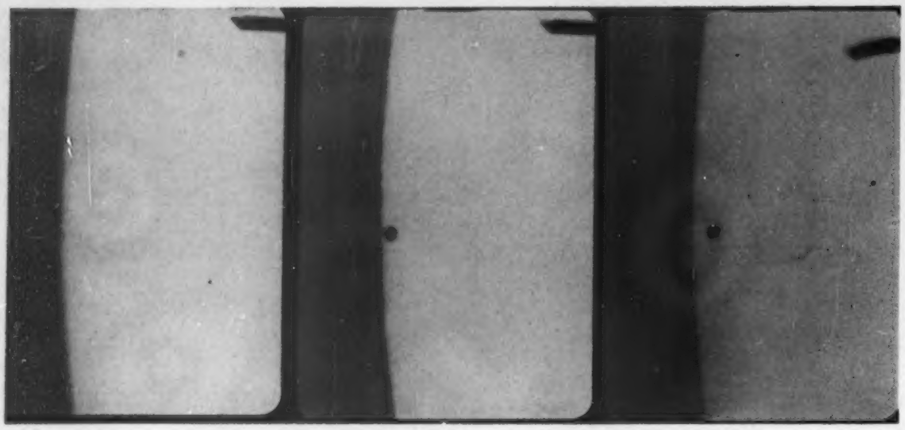
Mercury, photographed in 1934 in yellow light, by Lowell Observatory.

Considering all these difficulties and the small size of the quantities measured gives a good idea of the remarkable precision of astronomical measurements.

The orbit of Mercury is seen nearly edge on, but not quite. Actually it is inclined at an angle of seven degrees, but there are two times every year when the earth is so situated that the orbit is seen exactly edge on, about May 8th and November 10th. At these times, if Mercury is on the near side of its orbit it passes between us and the sun, and may be easily seen as a small, round, intensely black spot, moving across the sun's disk. If it passes near the center of the disk the duration of the transit is from five to eight hours, but otherwise it may be very short. There will be eight transits during the remainder of this century, two in May and six in November. The next one will occur on November 14, 1953, and this will be followed by one on May 6, 1957, and another on November 7, 1960, after which there will be no more until 1970. The transits of 1953 and 1960 will be favorable for observation in this country, but that of 1957 will occur in the middle of the night for us.

Observations of the exact time at which Mercury is seen internally tangent to the sun's disk are of some value for determining the motion of Mercury and the position of its perihelion. Such observations have been made at most transits since 1677, and, indeed, it was the observations of the transits up to 1848 which permitted the French astronomer Leverrier (the same who predicted the discovery of Neptune) to detect the discrepancy between observation and theory which nearly 60 years later was explained by relativity. In modern times, however, the meridian observations are more useful than the observations of the transits, due primarily to their greater number and to the improvements in accuracy that have taken place in recent decades. The possibilities of the transits have not yet been fully explored, and it is probable that a good series of 50 to 100 photographs of the sun taken with a long-focus camera on plates large enough to photograph the whole disk at one time, equally distributed throughout the whole duration of a transit, would yield information of value, if reduced and discussed with all possible care. Even so, a series of transits would have to be observed by such a method in order to obtain much worthwhile information, because it is not very useful to know the position of Mercury on a single day, no matter how accurately, unless similar observations made at other times are available. This method has been tried, I believe for the first time, at the Mount Wilson Observatory in 1940, and it is to be hoped it will be repeated.

Mercury passes behind the sun more frequently than it does in front of it,



The transit of Mercury on November 11, 1940, photographed by Edison R. Hoge with the 60-foot tower telescope at Mount Wilson Observatory. These frames are enlarged two times from motion picture film; the pointer in the corner indicates the time of each exposure. Mercury is the faint spot encroaching on the sun's disk. Mount Wilson photo.

but such phenomena cannot be observed (at least visually), and so far as I know, no one has ever bothered to make predictions of these events.

Another class of observations which would be of considerable value if they could be made would be accurately timed observations of occultations of the fixed stars by Mercury. Such occurrences are rare for the brighter stars that would be necessary for the purpose. I once examined the path of Mercury among the stars during six years, and found that during this time only one star brighter than the 7th magnitude was occulted, and this event was visible only from the middle of the Pacific Ocean.

When Einstein first announced the general theory of relativity many astronomers and physicists found themselves intuitively opposed to such a concept, and the confirmation of the theory given by the motion of Mercury helped greatly to convince many doubting persons that the theory was valid. Now the position is somewhat changed; most scientists have adopted more sophisticated methods of thought, and no doubt would continue to believe in relativity even if the motion of Mercury disagreed with it. In this case the discrepancy would be ascribed to some other cause as yet unknown. The perihelion of Mercury has therefore lost some of its interest, but Mercury has recently assumed a position of peculiar importance in connection with timekeeping; it is the most accurate clock in the solar system, at least the most accurate one that is accessible to astronomers at the present time.

Since time immemorial the earth has been our standard clock; the period of the rotation of the earth has been regarded as invariable, and until perhaps 25 years ago this assumption worked sufficiently well. But it has now been established that the earth does not rotate uniformly. In addition to the very gradual slowing down caused by the friction of the tides, there are rather abrupt changes from time to time, due to unknown causes, which cannot be predicted. These changes are too small to be detected by any man-made clocks (at least as yet), but they can be detected by astronomical observation.

To understand how this can be done, let us imagine that all the clocks on the earth were stopped suddenly for an hour and then started up again, and also that the earth stopped rotating for the same length of time, without any of us being aware of it. When we returned to our senses we should at first suspect nothing wrong (unless daylight saving time had also gone suddenly into effect). The sun would continue to transit the meridian at noon by the clocks. But when we came to observe the stars the situation would be different. During that hour that the clocks and earth were stopped, the sun would have moved amongst the stars about 1/24 of a degree, and the stars would all transit the meridian earlier than the predicted time, by about 10 seconds. The interpretation of the 10-second discrepancy would be that the clocks were all wrong by one hour. We might at first be reluctant to ascribe the discrepancy to an error in the clocks, but convincing evidence would be forthcoming from Mercury and the moon. While the sun was moving 1/24 of a degree among the stars, Mercury would move about a sixth of a degree, and the moon more than half a degree. It would be even more difficult to believe that the sun, Mercury, and the moon could conspire to play tricks on us than to be convinced of the truth.

This is roughly a description of what has actually happened from time to time, although of course the actual effects are much smaller, and the clocks and the earth have not really stopped at all. Instead the earth has speeded up or slowed down gradually by a very small amount so that the effects were not at once apparent, but could be discovered some time later, after observations of the stars, the sun, Mercury, and the moon had been collected and analyzed. The following table gives the corrections that ought to be applied to the time indicated by our clocks for some dates chosen to exhibit the changes best:

Year	*Correction to astronomical time*
1888	−7.9 seconds
1895	−7.0 "
1900	−3.9 "
1905	+3.1 "
1910	+10.0 "
1915	+16.6 "
1920	+20.8 "
1925	+22.9 "
1930	+23.1 "
1935	+23.3 "
1940	+24.5 "
1945	+26.5 "

It is easy to see that the fastest moving bodies are the ones most suitable for detecting these changes. The moon would be best of all, were it not that the gradual slowing down of the earth due to tidal friction, which cannot be predicted in advance, is accompanied by a speeding up of the moon in accordance with the law of conservation of momentum. The moon, therefore, cannot be trusted over a very long interval of time, although for shorter intervals such as a few decades it is better than Mercury for the purpose.

It is only fair to mention that although the error of our clocks is quite large according to modern notions of precise timekeeping, where calculations are made in thousandths of seconds, it is not worthwhile to take account of it for ordinary purposes. The error changes so slowly that it does not cause any trouble. The only practical effect is that on the average the sun comes to the meridian not at noon by the clock, but about 1/15 of a second earlier; and inasmuch as the actual sun is usually much more discordant with the clocks than this, because of the equation of time and the system of standard time zones, no one notices the error. It is only in the discussion of the motions of celestial bodies over rather long intervals of time that the error needs to be taken into account.

Another good reason for neglecting this error is that it is never known until after a long series of observations has been obtained and analyzed. Therefore, strictly speaking, we can tell what time it was a year ago, but we can never tell what time it is today; although it is not necessary to do so, even for the most precise scientific requirements on the earth.

In addition to the connection with relativity and with precise timekeeping, Mercury is very useful for a third purpose, that is, for weighing the planet Venus. It is, of course, not practicable to put Venus on the pan of a scales, and to balance the scales by putting pound weights on the other pan; but it is important to know its weight, or more

properly speaking, its *mass*, for reasons to be described later. The mass of a planet is not measured in pounds ordinarily, but in terms of the sun's mass. It could be converted into pounds, but this is not necessary for astronomical purposes. The mass of the earth, for example, is about 1/330,000 that of the sun, and the mass of Venus is about 1/408,000, roughly 4/5 that of the earth.

If a planet has satellites they may be used to determine its mass, but no satellite of Venus has ever been seen, and it is necessary to weigh Venus by measuring its gravitational influence on some other planet. The effect of Venus is to pull Mercury out of an exact ellipse; the actual orbit of Mercury is a very complicated curve in space, but the departures from an ellipse are very small, only a little more than the apparent diameter of the planet. These departures can be calculated very exactly, once the mass of Venus is known. What is done is to calculate them on the basis of an *assumed* mass of Venus. The actual departures are then measured and compared with the calculated ones. If, for example, they turn out to be twice as large, this means that the mass of Venus is twice as great as was assumed, and the assumed mass can be corrected to the right value.

Venus disturbs the earth and Mars as well as Mercury, and therefore we do not depend on Mercury exclusively, but on a combination of all the information that can be obtained from different sources. The different planets are weighed from time to time, as more accurate observations and more refined methods become available. The last time that Venus was weighed was by the writer a few years ago when he analyzed all existing observations of Mercury, about 10,000 in number, extending from 1765 to 1937. The result came out 1/409,000 of the sun's mass. Shortly before that H. R. Morgan and F. P. Scott had obtained 1/407,000 from the action of Venus on the earth. The true mass, therefore, cannot be very far from 1/408,000. A more accurate determination will be possible from the action of Venus on Mars as soon as the gravitational theory of the motion of Mars is accurately calculated.

One important reason for knowing the mass of Venus accurately is to make possible the calculation of its effect on the obliquity of the ecliptic. It is necessary to know this in order to make accurate predictions of the positions and motions of the celestial bodies. The obliquity of the ecliptic is the chief cause of our seasons. At the present time it is growing smaller, and the diminution is caused chiefly by Venus. If this effect were to continue indefinitely the time would eventually come when summer and winter would almost cease to exist, and the climate would be much the same the year around. This is not likely ever to happen. It is probable that after some hundreds of thousands of years the obliquity will stop decreasing and start to increase again. But no one yet knows with certainty whether this will be the case. Some light may eventually be thrown on this question as a by-product of research now in progress at Yale University Observatory, the Watson Scientific Computing Laboratory, and the Naval Observatory, under the sponsorship of the Office of Naval Research.

SKY BRIGHTNESS AT HIGH ALTITUDES

Pure science is again being benefited by experiments with V-2 missiles launched at White Sands Proving Ground. Two rockets were equipped with photoelectric tubes for measuring sky brightness, and a third such experiment is planned for the near future. Preliminary results from the first two have been reported to the Optical Society of America by H. A. Miley and D. F. McClellan, of the Watson Laboratories, AMC, Cambridge. They indicate "that it is relatively dark at a height of 25 kilometers, the brightness values being about 3 to 7 per cent of those measured near the ground for the respective chosen directions. The near-the-ground values are larger than might be expected from molecular scattering alone. This may indicate that weather conditions, dust, smoke, etc., are liberal contributors to sky light."

In Focus

PERHAPS the most famous patch of dark nebulosity in the sky is the southern Coalsack, principal interest in our back-cover picture this month. It is formed by a cloud of dust and gas approximately 500 light-years from the sun, its total absorption amounting to little more than one magnitude. In some of the denser portions it is as high as three magnitudes.

In the book, **The Milky Way,** the authors point out that largely because of the high contrast with the brilliant portion of the Milky Way that surrounds it, the Coalsack appears to the unaided eye as an intensely black cloud. The accompanying small-scale photograph of the Milky Way shows this effect also, but a telescope reveals the presence of numerous faint stars in the Coalsack itself. Long-exposure photographs, such as that on the back cover, show that there is still an average of one third as many faint stars in the Coalsack as in an adjacent area of the sky of the same size.

As in the small-scale picture here, the back cover is oriented with west at the top and north to the left (indicated by the direction of the long arm of the Southern Cross). Alpha Crucis is seen on the back cover as the very overexposed star near the top. Just to its left is the open cluster bearing Dunlop's number 292, while at the left edge just below the center is the cluster around Kappa Crucis.

The picture on this page shows the Cross with the Coalsack below it, Beta Centauri near the bottom center, and globular cluster Omega Centauri near the lower left. The heavy star clouds at the top of the picture are in the Carina region of the Milky Way.

The region of the Coalsack and the Southern Cross, with north at the left, the same orientation as that of the back cover of this issue. Harvard Observatory photograph.

Amateur Astronomers

Northeast Region of Astronomical League Is Formed

An ORGANIZATION meeting of the Northeast Region of the Astronomical League was held at Harvard College Observatory on Sunday, October 12th, following the annual fall meeting of the American Association of Variable Star Observers, one of the host societies. The Bond Astronomical Club and the Amateur Telescope Makers of Boston were the other hosts.

With Charles A. Federer, Jr., national vice-president, in the chair, the meeting got down to business shortly after 10 o'clock, establishing the boundaries of the region as the New England states, New York state, and northern New Jersey. Cards filled out by the delegates showed that nearly all member societies of the region were represented, 42 delegates being present in all. Interestingly enough, almost every delegate was associated with two or more societies. Member organizations in the region were represented as follows:

Aldrich Astronomy Club, Worcester, Mass.	3
A.T.M.s of Boston	10
AAVSO, Cambridge, Mass.	22
Astronomical Society of Maine, Portland	10
Bergen County Astronomical Society, Teaneck, N. J.	2
Bond Astronomical Club, Cambridge, Mass.	10
Junior Astronomy Club, New York City	1
New Haven Amateur Astronomical Society	3
R. P. I. Astrophysical Society, Troy, N. Y.	1

An invitation to hold the first regional convention in New Haven, Conn., during the 1948 Easter holidays was extended by the New Haven society, exact dates to be set later, an offer that was promptly, gratefully, and unanimously accepted.

Nomination and election of officers followed, interspersed, while ballots were counted, by discussion of activities and observational and research programs. Officers elected were: Donald H. Kimball, New Haven A.A.S., chairman; Chester Cook, Boston A.T.M.s, vice-chairman; Walter Reeves, Astronomical Society of Maine, treasurer; Robert Greenley, Bergen County A.S., secretary.

James B. Rothschild, executive secretary of the national organization, discussed the aims and functions of the league, and the co-ordination of national and regional programs. Dr. Walter O. Roberts, of the Harvard solar station at Climax, Colo., gave what proved to be a vitally interesting and instructive talk on solar observing, detailing certain points to which special attention by amateur observers should be paid, and stressing the value of hour-to-hour drawings of active spot regions.

Work for the practical amateur astronomer was outlined in a talk by Leon Campbell, recorder of the AAVSO, who pointed out the many programs which amateur observers without telescopic aid may enter into. He mentioned meteor and aurora observing, nova search, and variable star work, in all of which amateurs may make significant contributions.

By motion and unanimous vote it was decided to extend to all societies in the region a cordial invitation to join the Astronomical League.

Robert Greenley
Bergen County Astronomical Society

THIS MONTH'S MEETINGS

Chicago: At the regular meeting of the Burnham Astronomical Society on Tuesday, December 9th, Wagner Schlesinger, of the Adler Planetarium, will speak on "The Wise Men's Star." The meeting is at 8 o'clock at the Chicago Academy of Sciences.

Cincinnati: The Cincinnati Astronomical Association will hold its annual dinner meeting on Thursday, December 11th, at a place to be announced. Dr. Everett I. Yowell, professor emeritus of astronomy at the University of Cincinnati, is guest speaker.

Detroit: On Sunday, December 14th, at 3 p.m. at Wayne University, Dr. Leo Goldberg, of the University of Michigan Observatory, will address the Detroit Astronomical Society on the topic, "What's New on the Sun?"

Geneva, Ill.: "Terrestrial Effects of Sunspots" will be discussed by Professor Clarence R. Smith, of Aurora College, at the December 2nd meeting of the Fox Valley Astronomical Society. The group meets at the Geneva City Hall at 8 p.m.

Indianapolis: On December 7th the Indiana Astronomical Society program will consist of a "1947 Review" presented by the board of officers, at Odeon Hall at 2:15 p.m.

Madison: The December 10th meeting of the Madison Astronomical Society will be a symposium on variable stars, with three speakers participating. The meeting is at 8 p.m. at the Washburn Observatory.

New York: "The Depth of the Milky Way" will be discussed by Father Francis J. Heyden, S.J., of Georgetown University Observatory, at the December 3rd meeting of the Amateur Astronomers Association, at 8 o'clock in the American Museum of Natural History.

Pittsburgh: At the Amateur Astronomers Association meeting on December 12th, 8:15 p.m. in the Buhl Planetarium, Chief Meteorologist Henry Rockwood, of the U. S. Department of Commerce Weather Bureau in Pittsburgh, will speak on "Weather and You."

San Diego: Major Chapman Grant, of the U. S. Army, grandson of General U. S. Grant, will speak before the San Diego Astronomical Society on Friday evening, December 5th, at 7:30 p.m., Room 507 in the Gas and Electric Building. His subject will be, "Were the Carolina Bays Made by Meteors from an Exploding Comet?"

Washington, D. C.: Carl H. Gamble, president of the Popular Astronomy Club of Moline, Ill., will speak at the monthly meeting of the National Capital Astronomers on Saturday, December 6th, at 8 p.m. in the National Museum. The subject of his talk will be "Popular Astronomy."

Columbus Astronomical Society

At the regular monthly meeting on September 30th, the members of the recently formed Columbus Astronomical Society elected the first regular staff of officers. L. R. Stewart, an amateur of some years standing, was chosen as president. Assisting him during the year will be Vice-president Arch B. Tripler, Jr., Secretary-Treasurer Josephine Walcutt, and Program Chairman Kenneth Walker. Dr. J. Allen Hynek, director of the McMillin Observatory and a member of the physics and astronomy faculty of Ohio State University, is adviser to the society.

During its informal existence, which began in the spring of this year, the group had been led by a temporary staff of officers headed by William Koehl.

Tentative plans for the current year include telescope making, observing, and a series of lectures on the elementary principles of astronomy. Regular meetings are held on the last Tuesday of each month at McMillin Observatory, located on the Ohio State University campus.

ARCH B. TRIPLER, JR.

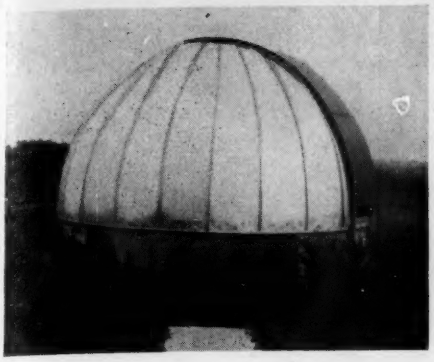
Kansas City Speaks

Since war clouds cleared sufficiently to show that there is still a sky over our 'scopes and workshops, Kansas City, Mo., is again bursting into activity. As C. Clyde Miller, prewar president of the local association, died several seasons ago, L. A. Weaver, former vice-president, called a meeting which about 40 persons attended. It was held at the Tarbell Observatory, and the original organization was revived with E. Dwight Tarbell as president and Edward F. Bowman as secretary.

Housed in the 16-foot dome at the Tarbell Observatory is a beautiful combination Newtonian - Cassegrainian, motor - driven 'scope designed and built by Mr. Tarbell. He is chief draftsman for a large architectural concern of national renown, so you can correctly guess that both the building and the instruments it houses are really precision built.

There are believed to be around 100 amateur-built telescopes in and near Kansas City. These range in size from four to 24 inches for reflectors, and there are some very fine refractors. Robert Willoughby is constructing an 8-foot dome for his 10-inch Cassegrainian. The writer is engaged in the preliminaries requisite for a large dome to house his 24-inch reflector.

Something of special interest could be told about each member. Mr. Weaver built a 12½-inch reflector for the Eastern Mennonite College in Harrisonburg, Va. C. Ed Miller, commercial photographer and globe trotter, built and presented a fine 10-inch reflector to the Reorganized Latter Day Saints College at Lamoni,



The **Tarbell Observatory dome, looking toward the south.**

Iowa. C. Ellsworth Brown, besides building several telescopes, has made some very nice clocks. Nora Witthar, of the Independence junior high school, sponsored the making of an 8-inch reflector by her general science pupils.

At each regular meeting a brief quiz is given on astronomy or telescope making. A light 10-hour course in astronomy is offered in five 2-hour class sessions for the benefit of new recruits. Interest is intense, and we hope to make this feature continuous by starting new classes as old ones are finished.

We are fostering a move to provide a planetarium for Kansas City. Another current club activity is a portable library, which will soon be a reality, we hope. Astronomical books and periodicals would attend each meeting with the librarian and return home again with him, books being available at either place.

Among our group are some radio hams, and we hope to revive a prewar custom of making observations of meteor showers by recording meteors from two or more bases, all bases maintaining short-wave radio contact throughout the night.

When passing through the Heart of America, all amateur astronomers are invited to look us up, and, if convenient, meet with us.

EDWARD F. BOWMAN, secretary
8500 E. 19th St., R. 6
Kansas City 3, Mo.

LETTERS

(Continued from page 30)

Sir:

Owing to circumstances beyond our control, we were without a telescope in the dome of our small Vesper Heights Observatory, so we decided to obtain a Spitz planetarium. Accordingly, the inventor, Armand N. Spitz, of the Franklin Institute in Philadelphia, brought one in October, and installed and demonstrated it. We had the distinction of being the first school to obtain one of these instruments. The illusion of the night sky was striking, and the "ah's" from the audience of faculty members and students attested the close approach to the excellence of the large planetariums. It is the perfect complement to our telescopes which we wheel outdoors for use.

M. T. BRACKBILL
Eastern Mennonite College
Harrisonburg, Va.

AAVSO Holds Annual Meeting at Harvard

On FRIDAY EVENING, October 11th, the 36th annual meeting of the American Association of Variable Star Observers opened with a gathering at the Harvard Observatory, with members of the Bond Astronomical Club as guests. The speaker was AAVSO President Charles H. Smiley, of Ladd Observatory, Brown University, whose talk on "15,000 Miles and 15,000 Observations," illustrated by colored slides, recounted the experiences of the Brown University-Skyscrapers expedition to the May 20th eclipse. Although they were clouded out on eclipse day, on the entire trip the party made observations of the altitude of the sun at sunrise and sunset, obtaining data necessary for compiling tables of atmospheric refraction.

Observing, refreshments, and informal discussions concluded the evening program. The business session was held on Saturday morning, also at the observatory. Announcement was made of the 22 persons who had joined the society since the spring meeting. Two outstanding observers were elected to honorary membership: Rev. T. C. H. Bouton, St. Petersburg, Fla., and R. G. Chandra, of Bagchar, India.

Newly elected council members are Ralph N. Buckstaff, Oshkosh, Wis., C. F. Fernald, Wilton, Me., Clinton B. Ford, Windsor Locks, Conn., and Dr. P. M. Millman, Ottawa, Canada. Dr. Marjorie Williams, of Smith College, is the new president of the AAVSO, with D. W. Rosebrugh as first vice-president, and Neal J. Heines as second vice-president. The secretary, treasurer, and recorder are serving for another year, H. M. Harris, of South Portland, Me., P. W. Witherell, Jamaica Plain, Mass., and Leon Campbell, of Harvard Observatory, respectively.

Reports of committees were heard at the business session, and an increase in activity was to be noted in practically all of the programs sponsored by the AAVSO. Twelve papers were presented at the morning and afternoon sessions, a third of them concerning the sun, and the others on a variety of topics of interest to variable star observers.

The 16th annual report of the recorder revealed a considerable growth in the number of observations here and abroad. For the year, the grand total was slightly over 50,000, nearly 6,500 more than last year. As for many recent years, Mr. Fernald leads the individual observers, with 6,649 estimates of variable star brightnesses; next is R. P. de Kock, of Capetown, South Africa, with 4,616 observations; and third is C. Chassapis, of Athens, Greece, with 3,502. Reports were received from 39 observers in 11 foreign countries; of these, 11 observers were in Greece, five each in Australia and Canada, and three each in South Africa and India. Ninety five of the 155 persons who contributed the observations are regular observers. The 39 foreign observers accumulated 44 per cent of the grand total.

The AAVSO itself helped support astronomy abroad by donating 40 books, which were duplicates in its library, to an observatory in Czechoslovakia. Among the publications of the society during the year were Harvard *Annals* No. 110, Addenda, and No. 116, 1, the latter containing some 22,000 original observations of long-period and special variables.

In addition to the great activity of the solar division, under the chairmanship of Mr. Heines, there was reported an increase in observations under the direction of the occultations committee, Dr. Alice H. Farnsworth, Mt. Holyoke College, chairman. During 1946, 120 observations of occultations were received, and all but six have been sent to England for reduction; this is 50 more than in 1945. Thirty-one observers made the 120 observations, with E. A. Sill, Mamaroneck, N. Y., contributing 25; O. E. Monnig, Fort Worth, Tex., 13; and Donald Mary, Louisiana State University, 11. Dr. Farnsworth asked for more observations, but to do good work an observer should have a suitable telescope and adequate facilities for timing the occultations.

The meeting officially concluded on Saturday evening, following a dinner served at the observatory. Among the speakers after dinner was Dr. Harlow Shapley, who presented his traditional highlights of astronomy during the past year. He mentioned the tremendous sunspot activity of the early months of 1947, including the record-breaking spot in April; infrared photography of the solar spectrum from V-2 rockets; the work of Carl A. Bauer on the helium content of meteorites, and its possible cosmogonical significance; the completion of the 200-inch mirror; the work on the rotation of stars, as shown by the Zeeman effect, by Babcock and Chapman.

At the close of the dinner, the hall was darkened for a demonstration of the new Spitz planetarium, and the group spent considerable time in the always fascinating occupation of stargazing and constellation study. Many members remained in Cambridge to attend the organization meeting of the Northeast Region of the Astronomical League the next day.

Astronomical League Members

Two societies which have recently become members of the Astronomical League are the Springfield Telescope Makers, of Springfield, Vt., and the Palo Alto Astronomy and Telescope Club, of Palo Alto, Calif.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 77th meeting of the American Astronomical Society at Dearborn Observatory in September. Complete abstracts will appear in the Astronomical Journal.

Interstellar Absorption

A LEAD-SULFIDE photoconductive cell furnished by Dr. R. J. Cashman, of Northwestern University, has been used by Dr. A. E. Whitford, of Washburn Observatory, at the focus of the 100-inch telescope at Mount Wilson Observatory to measure the infrared radiation of stars. Suitable filters isolated bands at effective wave lengths 8800 and 21,000 angstroms (0.88 and 2.1 microns). The reddened *B* stars Zeta Persei, 9 Cephei, 55 Cygni, and the reddened *F* star 44 Cygni have been compared with unreddened stars of similar type. When combined with results previously obtained in six colors ranging from the ultraviolet to the infrared, the new data yield important information concerning the nature of the absorbing material in interstellar space. There is evidence in favor of the interstellar particles being dielectric (nonconducting) rather than metallic.

A Double Anniversary

YERKES OBSERVATORY and the American Astronomical Society are 50 years old, and the concluding portion of the 77th meeting of the society was therefore held at Yerkes Observatory on Saturday morning, September 6th. There, in a special anniversary session, two papers were given, "The American Astronomical Society, 1897-1947," by Dr. Joel Stebbins, of Washburn Observatory of the University of Wisconsin, and "The Yerkes Observatory, 1897-1947," by Dr. Otto Struve, of Yerkes and McDonald Observatories. The texts of these papers are published in *Popular Astronomy* for October, 1947. Also, in that same issue is a general account of the 77th meeting, written by Dr. Curvin H. Gingrich, editor of *Popular Astronomy*.

During the early part of the week of September 7th, Yerkes Observatory held a symposium on planetary atmospheres. Many of those in attendance at Dearborn and Yerkes for the society meeting stayed to participate in the symposium.

Parallax of Ross 248

EXCLUDING OUR SUN, Ross 248, a 12th-magnitude star in Andromeda, is the seventh nearest star known at present. It is very red, spectral class *M6*, and appears to move almost due south 1½ seconds of arc per year. During the past 10 years, on 164 different observing nights, astronomers at the Sproul Observatory of Swarthmore College have taken a total of 350 plates with 684 exposures of the region of this star, using the 24-inch Sproul refractor.

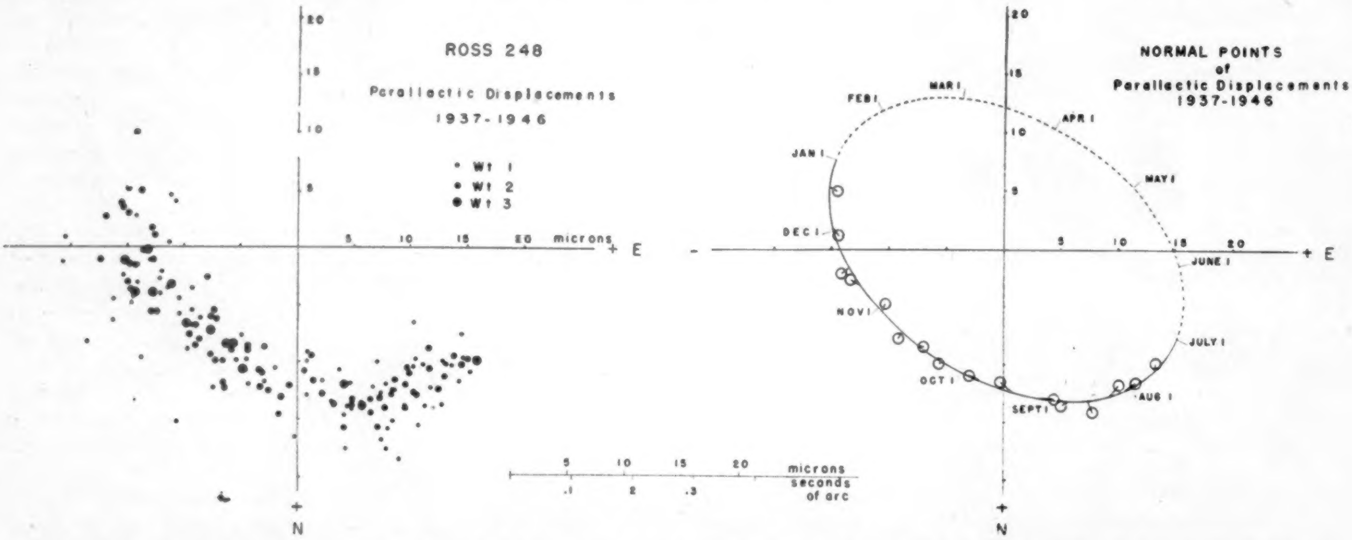
Prime purpose of the Sproul program on nearby stars is to establish variable proper motions which may indicate the presence of unseen companion stars. Dr. Peter van de Kamp reported that for Ross 248 no evidence of measurable perturbation is found over the decade 1937-1946. The parallax measurement possible from the Sproul plates is of very high accuracy, first because the position of the star is not affected by any orbital motion, and second because the number of plates available is almost 20 times that used in conventional parallax determinations.

The Sproul parallax agrees well with previous determinations at Mount Wilson and McCormick observatories. It is 0".320 with a probable error of 0".003, placing the star at a distance of about 10.2 light-years. Ross 248 has an absolute magnitude of 14.7, or a luminosity about 13/100,000 that of the sun.

RR Lyrae

FIRST short-period Cepheid variable star to be found outside a globular cluster was RR Lyrae, discovered by Mrs. W. P. Fleming at Harvard some 50 years ago. Since then nearly a thousand more such variables have been found outside of globular clusters, but RR Lyrae still retains a place of special interest, for it has a secondary period of light variation requiring about 41 days as contrasted to its principal period of about 13 hours. In September, 1946, at a conference at the Leiden Observatory, Holland, Miss H. A. Kluyver described recent results by L. Detre on the light curve of RR Lyrae and requested that radial velocity determinations be made covering the entire 41-day secondary period.

Between June 3rd and July 15th of



Every star appears to change its position during the year in a small orbit, the size of which depends on the star's distance. Plotted here (left) are the apparent positions of Ross 248 during the years 1937-1946, as observed with the long-focus refractor of Sproul Observatory. They reveal the parallactic displacements from the heliocentric position, which is at the center (origin of co-ordinates). The observations have been grouped into 16 points (right), based on an average probable error of 0".006, which is indicated by the radii of the circles. These normal places clearly determine the part of the star's parallactic orbit accessible to observation. Since the observations are always made close to the meridian, the other half of the parallactic orbit corresponds to daytime culminations and is not observable. Diagrams by Sproul Observatory.

this year, Dr. Otto Struve, of Yerkes and McDonald Observatories, secured with the 82-inch McDonald reflector nearly 400 spectrograms of the variable, using the Cassegrain quartz spectrograph with 500-millimeter camera—linear dispersion of 40 angstroms per millimeter at wave length 3933 angstroms. The exposure times ranged from one minute to one hour. The rapid changes observed in the star's spectrum indicate the importance of being able to obtain many spectra in a short time, as well as the necessity for almost continuous observation of such changes before conclusions may be drawn from the observations.

One of the first results was the discovery of peculiar hydrogen-line contours, on the ascending branch of the principal light curve. On June 5th and 6th, at approximately the time of median increasing brightness, the lines of hydrogen gamma and delta consisted of exceedingly narrow and weak absorption cores resembling the hydrogen lines in certain shell-type spectra. These cores were bordered on the violet side by a strong but narrow emission line. A very faint red emission border may also have been present. This structure was superposed over an exceedingly broad and peculiarly shallow absorption line. The entire phenomenon lasted only about 20 minutes. Prior to it the hydrogen lines were fairly strong and fairly narrow—more-or-less normal for a high-luminosity star of type *F*. Afterwards they were strong and broad, normal for an *A*-type star of average luminosity.

This remarkable phenomenon was observed on all available occasions throughout the 41-day secondary cycle. It became less conspicuous in the middle of June, and disappeared completely in the latter part of the month. In this stage the narrow lines of type *F* became rapidly converted into the broader ones of type *A*, without passing through the peculiar stage. But early in July the peculiar contours of the hydrogen lines again became easily observable and by July 15th the entire phenomenon closely resembled that of June 5th. A correlation with phase in the 41-day cycle is strongly indicated.

On one occasion, Dr. Struve succeeded in obtaining a fine series of short exposures throughout the critical stages. The narrow absorption cores which are observed so temporarily must lie in the uppermost strata of the star's atmosphere. Before the cores have disappeared, broad, shallow lines from deeper layers make their appearance, with a negative velocity shift compared to the narrow cores. Dr. Struve pointed out that when we measure the relative radial velocity as zero, near the phase of median increasing brightness, the atmosphere of the pulsating variable star really consists of two layers having different velocities. The upper layer is still "falling into the star," while the deeper layer is already moving outwards. It is clear that we now must use caution in attributing to the main body of a pulsating star motions which strictly apply only to very limited strata of its atmosphere.

A Peculiar Variable

ECLIPSING VARIABLES exhibit a wide variety of light curves, but none quite like that of the eclipsing component of the visual double star 44i Bootis has been observed heretofore. Recently, photoelectric observations of this star have been made at Washburn Observatory of the University of Wisconsin. The light curve shows a perfectly symmetrical eclipse followed by a period of about 30 minutes in which the light remains constant before increasing to full maximum brightness and returning again in another 30 minutes. The short, nearly constant phase is then repeated before the next eclipse begins. Dr. O. J. Eggen, who discussed the observations, believes this behavior may be related to nonsynchronism of the rotational and orbital periods.

This eclipsing binary is one of the variables of the W Ursae Majoris type, characterized by the shortness of their periods of revolution (usually less than a day and a half); the equality in brightness, size, and spectral class of the components; and their close proximity to each other, which results in considerable tidal elongation of each component. In the case of 44i Bootis B, photometric evidence supports the assumption that the eclipsing stars are in actual contact, according to Dr. Eggen.

Stellar Atmospheres

SYMPOSIUM papers were presented by seven astronomers at the afternoon session on September 4th. They were Dr. Bengt Stroemgren, of Copenhagen University Observatory, now visiting Yerkes; Drs. P. C. Keenan and J. A. Hynek, Perkins Observatory; Dr. Jesse L. Greenstein, Yerkes Observatory; Dr. L. H. Aller, Kirkwood Observatory; Dr. Andrew McKellar, Dominion Astrophysical Observatory; and Dr. Alfred H. Joy, Mount Wilson Observatory.

The spectrum of a star reveals the presence of absorption lines of the various chemical elements present in its atmosphere. With large spectrographs on modern telescopes, such as the coude spectrograph of the McDonald Observatory reflector, it is possible to obtain spectra enabling spectrochemical analysis of many stars on a scale hitherto applied only to the sun and a few hot stars. In stars similar in temperature to the sun a thousand spectral lines can be measured and identified with elements present on the earth. If the strengths, or intensities, of the lines are also measured, the quantities of the elements present can be determined.

One of the most fundamental questions of modern astrophysics is whether or not the various chemical elements found on the earth occur in the sun and the other stars in exactly the same proportions. This problem is important in considering the origin of the stars, and of the earth; it is also important in determining the source of the nuclear energy of the stars — any abnormal abundances may afford clues to the nuclear processes at work.

If all stars have identical compositions with the sun, it should be possible to predict in detail what the spectrum of a star should look like, from its temperature, size, and weight. This complex theoretical process has been carried out by Dr. Greenstein for four stars of type *F*, temperatures near 6,000° centigrade. Three are dwarfs about five times brighter than the sun and one, Rho Puppis, is a supergiant about 1,000 times brighter. By measuring the intensities of about 300 lines in each spectrum, it has been possible for Dr. Greenstein to determine the number of atoms of various elements in different stages of ionization, and to compare these with the sun.

Certain general features have been found from this study. The more luminous a star is, the greater the turbulent motion in its atmosphere — supergiant stars are in violent boiling motion, with clouds of gas rising and falling at speeds up to five miles per second. After allowing for these effects, and for changes of temperature and pressure, it was found that three stars, Procyon, Theta Ursae Majoris, and Rho Puppis, showed only minor differences in composition from the sun.

The fourth star, Tau Ursae Majoris, the first ever studied in detail of the so-called "metallic-line *A* stars," proved an exception. A faint object near the bowl of the Big Dipper, this star is intrinsically perhaps eight times as bright as the sun, and a bit hotter. It possesses, however, a remarkable resemblance to the supergiant, Rho Puppis. It has considerable turbulence, low pressure, and a very transparent atmosphere. Furthermore, a large number of the spectral lines of various elements are weakened; large apparent differences in the abundances of the elements occur. Calcium, magnesium, scandium, and zirconium are only 1/10 as abundant as in normal stars; titanium, vanadium, strontium, and yttrium are about half as abundant; while nickel, zinc, and europium seem to be four times too abundant. If these changes of a large number of chemical elements should prove to be real abundance differences, Dr. Greenstein believes we may have to assume that some stars have had a different origin or a different evolution from others.

The only other possibility seems to be

a very abnormal distribution of the amount of the star's radiation in the far ultraviolet. If a star is hot, it has large amounts of ultraviolet light, and can ionize most of the elements in its atmosphere, thus weakening certain spectral lines present. This is not true in Tau Ursae Majoris; the elements weakened would be excessively ionized by light between 1000 and 800 angstroms, but elements with ionization energies which lie both above and below this range are found to be normal in abundance. The limited range of wave length of the excess energy required has never been observed in other stars, and it cannot be theoretically explained. If this latter hypothesis is abandoned, we shall necessarily conclude that the elements vary in abundance from star to star.

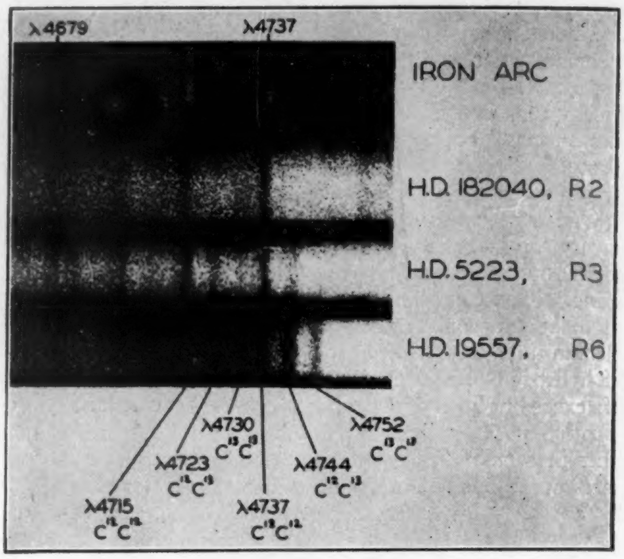
Isotopes of Carbon

TURNING to individual elements and their isotopes, Dr. Andrew McKellar, of the Dominion Astrophysical Observatory, has measured the relative abundances of the carbon isotopes, C^{12} and C^{13}, in the atmospheres of the *R*-type red giant stars. This study is of great importance, for the carbon cycle of energy generation in the sun and other main-sequence stars begins with C^{12}, and involves also C^{13}.

The only element which can be studied for isotopes by its atomic spectrum is hydrogen. Deuterium, or heavy hydrogen, of atomic weight 2, gives spectral lines which are shifted the relatively large distance of about two angstrom units to the violet of each of the well-known Balmer series lines of ordinary hydrogen. Shortly after the discovery of heavy hydrogen in 1932, Menzel and also Unsöld sought its lines in the spectrum of the sun and concluded that it was not present in detectable amounts. Since then, Dr. McKellar and others have looked for heavy hydrogen in stellar spectra but have found no trace of it.

For all the elements heavier than hydrogen, recourse must be had to molecular spectra — isotopic molecules give rise to bands which are shifted by readily detectable amounts. Molecules with bands of appreciable intensity in stellar spectra, and which may therefore be examined for isotopic features, include C_2, CN, CH, TiO, ZrO, NH, OH, and MgH. Isotopic forms have up to now been found in stellar spectra only for carbon; the others should be studied in the spectra of stars in which the appropriate bands occur. The most promising cases would appear to be TiO and ZrO in *M* and *S* stars.

At the Dominion Astrophysical Observatory, despite the faintness and extreme redness of most of the cool "carbon" stars, observational data have been collected for 21 stars of type *R* and 25 of type *N*. The spectrograms were made with a single-prism spectrograph attached to the 72-inch reflector. Of the 21 *R* stars for which detailed analysis has been made, there are three in which little evidence of C^{13} is present. Maximum concentrations of the C^{13} isotope are one part in 33, in 65, and in 84, respectively. Terrestrial samples of carbon give relative intensities of C^{12} to C^{13} of about 90 or 100 to one, and these three stars, therefore, seem to have atmospheres similar to the earth's composition in this respect. Dr. McKellar pointed out that the three stars have by no means the weakest bands due to ordinary carbon. For six more stars the carbon bands are so strong that significant results could not be obtained in the study.



Isotopic carbon bands in the spectra of R-type stars, illustrating three cases from Dr. McKellar's program. The star HD 182040 shows the $C^{12}C^{12}$ molecule's main bands with moderate intensity, but no isotopic bands; in HD 5223 the C^{12} to C^{13} ratio is easily measured, giving a ratio of about three to one; HD 19557 has bands of both isotopes, but they are too intense to give reliable ratios. Courtesy Dominion Astrophysical Observatory.

The other 12 stars show a surprising and wholly unexpected uniformity in their relative carbon isotope abundance, the mean ratio of C^{12} to C^{13} being only three to one. Dr. McKellar believes that this establishes a real difference of great significance in this abundance ratio in different stellar atmospheres. He said it was tempting to classify the *R* stars into two groups, one with the ratio of carbon 12 to 13 high, at least 50 or more, and the other with this ratio about 3.4 to one.

Dr. McKellar reported that he had discussed the nuclear physics aspects of the problem with Dr. Enrico Fermi, of the University of Chicago, when the latter visited the Pacific Coast in July. From the discussion came a very tentative explanation of the observational results, namely that possibly in the original material of which stars were made the C^{12} to C^{13} ratio was fairly low, say about three to one. It would remain at this value through the red giant stage of the star's life, until the carbon-nitrogen cycle started. The cross section of the C^{13} atoms for bombardment by protons is roughly 90 times as great as is that of C^{12}, as determined in the laboratory by nuclear physicists. Thus, the C^{13} would be used up more rapidly than the C^{12} (which is the end product of the cycle), and the ratio would gradually increase to the final value of about 90 to one when the carbon-nitrogen cycle had finally reached equilibrium.

As there would be a stage when the cycle was becoming established when the abundance ratio would be changing constantly, the carbon isotopic ratio might give valuable information as to the stage of evolution of individual stars. Further work by theoretical physicists is needed to put the subject on a firm basis, and to provide a proper time-scale for it.

Spectra of Variables in Globular Clusters

WITH the 100-inch telescope and low-dispersion spectrographs, the spectra of 27 of the brighter variable stars in 12 globular clusters have been photographed and analyzed by Dr. Alfred H. Joy, of Mount Wilson Observatory. These spectra, together with the light curves previously determined by photometric observers, make it possible to assign these stars to the classes known among variable stars in our galaxy.

On account of their faintness, the cluster-type variables with periods less than a day have not been observed. Of the 27 stars studied, seven with periods from 1.4 to 2.8 days and with early-type spectra varying from *A*4 to *F*3 may be closely related to the cluster-type variables. The clusters have only one Cepheid variable in the period range three to 13 days, where most of the galactic Cepheids are found.

In the group having periods from 13 to 33 days, 13 variables were observed, at least six with hydrogen emission lines and probably belonging to the W Virginis class of variables. The remaining six stars have long periods from 50 to 106 days; their spectra show them to be supergiants varying from c*G*0 to c*G*8.

Three of the six show hydrogen emission and should probably be assigned to the RV Tauri class; the others may be irregular variables. No Mira-type variables were found in the clusters.

The distribution of the variables of the clusters among the different classes indicates that the population of the clusters is made up of stars which are similar to the high-velocity stars of our galaxy.

Messier's Catalogue

FOR TWO YEARS PAST, Dr. Helen Sawyer Hogg, of David Dunlap Observatory, has been working on an extensive bibliographical compilation of globular clusters, listing all published references under the individual cluster concerned. During the course of her work, Dr. Hogg found a letter from Pierre Méchain in Paris to M. Bernouilli, published in Bode's *Jahrbuch* for 1786. This letter clears up the identification of No. 102 in Messier's famous catalogue of nebulous objects.

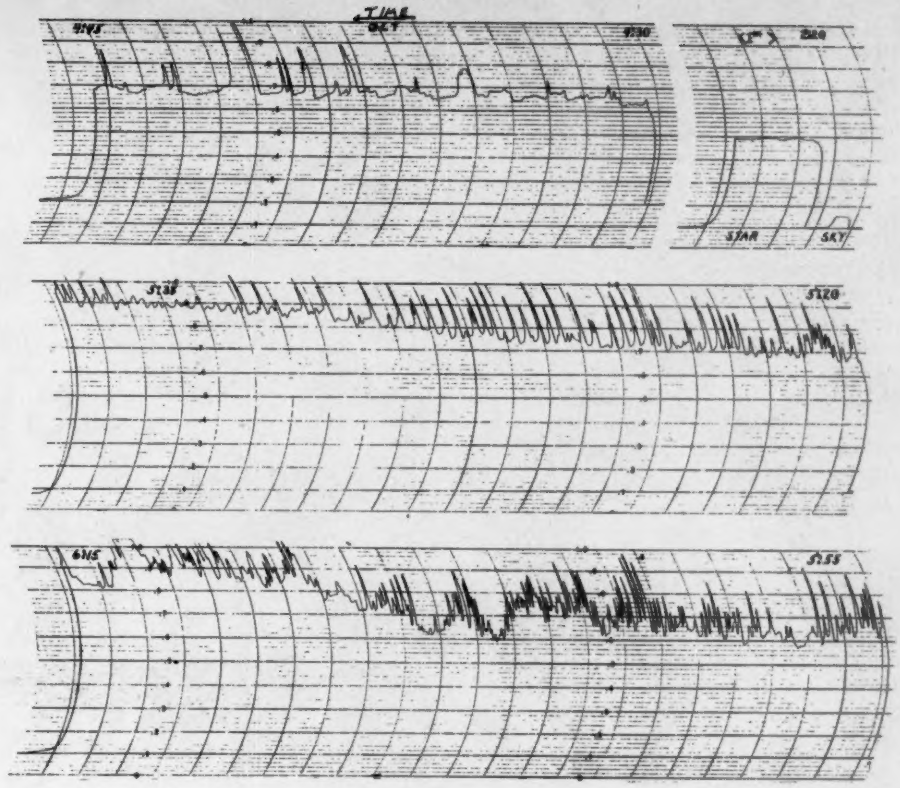
Messier's catalogue is really a collection of several papers: 45 objects were listed in 1771; a total of 68 was given in 1780. In 1781, Messier published numbers 69 to 103, of which 24 were objects discovered by Méchain (who was also the discoverer of Tuttle's and Encke's comets). Although Messier confirmed the discovery of most of these, Nos. 101, 102, and 103 are listed as seen by Méchain only.

In the letter now brought to light, Méchain corrected the listing by stating that No. 102 is "one and the same with No. 101," and that Messier made a mistake in reading its position from the star chart. Some astronomers had tentatively identified M102 as the spiral galaxy NGC 5866.

Dr. Hogg suggests the addition to Messier's catalogue of four other objects found by Méchain, three spirals and one globular cluster.

SYMPOSIUM ON EARTH'S ORIGIN

Part of the program of the Section D (astronomy) meeting of the American Association for the Advancement of Science in Chicago this December will be a symposium on "The Origin of the Earth." Held jointly with Section E (geology), the symposium is scheduled for December 27th at the Sherman Hotel at 2:00 p.m., with Dr. F. R. Moulton presiding. Speakers include Dr. Kirtley F. Mather and Rev. James B. Macelwane, of the geology departments of Harvard and St. Louis universities, respectively; Dr. Harrison S. Brown, of the University of Chicago's Institute of Nuclear Studies; and Drs. William J. Luyten and Fred L. Whipple, of the astronomy departments of the University of Minnesota and of Harvard.



On tracings made during the night of September 24-25, 1947, the two shown here in the upper right marked SKY and STAR give the relative brightnesses of the blank sky and the light from a star through focal diaphragms of 5'.9 and 1'.4, respectively. The remaining tracings show the general increase in the brightness of a patch of blank sky at the zenith as well as fluctuations in brightness caused by the auroral streamers. The lower level recorded before and after each tracing represents the zero reading. Courtesy Washburn Observatory.

AURORAL PHOTOMETRY

BY OLIN J. EGGEN

Washburn Observatory, University of Wisconsin

THE PHOTOELECTRIC photometer constructed by Dr. A. E. Whitford, and currently in use at the Washburn Observatory, is similar to that described by Dr. Gerald E. Kron in the October, 1947, issue of *Sky and Telescope*, with the exception that the photocurrent is registered on an Esterline-Angus recording milliammeter instead of by visual reading of a galvanometer scale.

While preparing this photometer for use on the evening of September 24, 1947, it was noted that conditions were quite suited for accurate photometry. The transparency of the cloudless sky was judged to be 4 on a scale of 5, and a moderate west wind eliminated a smoke hazard which lies south of the observatory. A not uncommonly bright auroral display was also noted. After the observations had been in progress for approximately two hours, irregularities began to appear in the deflections, as can be seen in the deflection marked STAR on the accompanying illustration. For accurate results the amount of the deflection must be read to 1/10 of the small scale divisions, so these irregularities rendered the observations of the brightness of the star useless.

When they were first noticed, it was assumed that the irregularities were caused by a high layer of "invisible" clouds, for previous experience with the photomultiplier has revealed it as an excellent "cloud detector," but the sky showed no other evidence of this trouble. While I was searching visually for the responsible clouds, however, the real cause became evident, for the faint auroral glow noted at dusk had grown into one of the most active auroral displays I have ever seen in this part of the world. The telescope was then turned to the zenith and long, continuous exposures made on the blank sky through a focal diaphragm of 5.9 minutes of arc. Some of these tracings are shown in the illustration. The time increases from right to left and is given in Greenwich civil time of September 25th, six hours fast of standard time at Madison.

The tracing beginning at 4:30 shows an increase in the deflection caused by the sky light of greater than eight times

(Continued on page 41)

NEWS NOTES

By Dorrit Hoffleit

THE ATMOSPHERE OF MARS

With an infrared spectrometer employing a Cashman lead-sulfide cell, 1,000 times more sensitive than previous such instruments, Dr. Gerard P. Kuiper, of the Yerkes and McDonald Observatories, has been examining the spectra of celestial objects at wave lengths 1 to 2.5 microns. Thus he has found that the atmosphere of Mars contains at least as much carbon dioxide as the earth's atmosphere. The poisonous gases, methane and ammonia, prominent in the atmospheres of the major planets, are absent on Mars.

Dr. Kuiper believes that the Martian polar caps are probably ordinary snow and clouds (water). This he hopes to test on February 17th, when Mars will be at opposition and near aphelion, 61 million miles from the earth and not quite 155 million from the sun. If the polar cap visible at that time is large enough for Dr. Kuiper's test, it will be possible to measure the amount of water on Mars with the new instrument. He also plans to study the dark areas for evidence of vegetation.

THREE OF THE PROBLEMS

Three typical problems, the solution of which would alone justify the construction of the 200-inch telescope, were discussed in detail recently by Dr. Edwin P. Hubble, of Mount Wilson Observatory, in the Alexander F. Morrison lecture of the Astronomical Society of the Pacific. He cited examples to represent respectively three of the observational advantages which will accrue from the great light-gathering power of the new instrument: resolution, dispersion, and depth penetration.

Perhaps the most popular problem for which great resolution is required is that of the canals of Mars. Numerous first-rate visual observers have flatly contradicted one another on the question of the existence of fine straight markings on the ruddy planet. Photographically, the moments of good seeing have been too short, and fine details have become blurred and unrecognizable. With the 200-inch, however, time exposures will not be necessary; during the fleeting instants of perfect seeing a few pictures should catch the same wealth of detail as seen by visual means. Not until the reality of the markings called canals is established beyond any doubt can we begin to consider the question of intelligent beings postulated to have built them. (The Mount Wilson astronomer seems inclined to accept the intelligent beings in case the canals prove real.)

The example illustrating the need for dispersion deals with the determination of the relative abundances of the various chemical elements in the stars. The sources of stellar energy, the origin of the elements, the history of the universe and its future evolution, are all problems related to the need for spectra of higher dispersion and resolution. Dr. Hubble mentioned that it is becoming possible to speculate on the building up of all elements from the primitive hydrogen atoms. "These speculations may be guided by the observed relative abundances of elements in stars of widely different physical characteristics."

Finally, the depth-probing problem is most typically Dr. Hubble's own. The space penetrated by the 100-inch telescope revealed two major facts: fairly uniform distribution of galaxies on the grand scale; and apparent recessional velocity proportional to distance. Is the latter a real effect of an expanding universe, or does it give a clue to some unknown feature of radiation (an increase of wave length with age since the light left the galaxies)?

If the galaxies are receding, their apparent brightnesses should be less than if they are stationary. "The stream of light quanta from a moving light is thinned out by recession so that fewer per second reach the observer," Dr. Hubble said. If the red shifts are due to recession, the effects on the brightness of the galaxies should become appreciable at a few thousand miles per second and conspicuous at several tens of thousands. Thus, the effect should be appreciable at the limit of the 100-inch and unmistakable at that of the 200-inch, where the dimming factor would approach 40 or 50 per cent.

PROGRAM FOR GALACTIC ROTATION

The period of rotation of the Milky Way in the vicinity of the sun is estimated to be about 200 million years. Relative to the stars in our vicinity, distant galaxies should therefore appear to move about 0.3 seconds of arc in 50 years. This is large enough for accurate measurement, and a long-range program is now under way at the Lick Observatory for investigating galactic rotation.

A 20-inch astrograph, built by the Warner and Swasey Company with a Fecker lens designed by F. E. Ross, was donated by the Carnegie Corporation. The quadruplet lens, corrected for wave length 4340 (blue) gives excellent definition over a 17- by 17-inch plate, showing stars of the 18th magnitude in two hours. To cover the sky north of $-23°$, 1,246 plates spaced five degrees apart are required. Ultimately, a second lens, corrected for 7000 angstroms (red), will be installed on the same mounting so that red and blue plates may be taken simultaneously. After the first series of plates on this program is completed, several decades must elapse before the second series is begun for the measurement of change of position of the stars relative to the distant galaxies.

METEORITE'S FORMER ORBIT

Seventeen years after the accident the circumstances of an intra-solar-system traffic accident have been reconstructed. On February 17, 1930, an 800-pound meteorite landed near Paragould, Ark. It was one of the three major segments and is the largest meteorite whose time of fall is known. Observers in Tennessee, Missouri, and Arkansas had seen the meteor during its flight through our atmosphere. Now (according to a press release) the data collected have been analyzed by C. C. Wylie, Harvey E. Nelson, and Warren J. Thomsen, of Iowa State University. They find that the meteoroid's orbit was an ellipse whose maximum distance from the sun was three times the earth's, and whose closest approach to the sun was somewhat less than the earth's distance. There were no traffic laws to govern the behavior of either earth or meteoroid at the intersection of their orbits.

CIVIL SERVICE ASTRONOMER EXAMINATION

Announcement has been made by the U. S. Civil Service Commission of an examination for filling positions in astronomy in Washington, D.C., and nearby Virginia and Maryland. A bachelor's degree in astronomy plus additional professional or graduate experience, or considerable progressive technical and professional experience, are minimum requirements. No written test is required. The salaries range from \$3,397 to \$7,102 a year.

Full information and application forms are available at most first- and second-class post offices, from civil service regional offices, or from the U. S. Civil Service Commission, Washington 25, D.C.

AMERICAN ASTRONOMICAL SOCIETY

The 78th meeting of the American Astronomical Society is scheduled for December 28-31, 1947, Sunday through Wednesday, with sessions at the McMillin Observatory of Ohio State University, in Columbus, and Perkins Observatory, at Delaware. On Monday evening, December 29th, Dr. Walter S. Adams, emeritus director of Mount Wilson Observatory, will deliver the second Russell lecture, on "Gaseous Clouds in Interstellar Space." Another special feature of the meeting will be a symposium on "The Relation Between Spectral Characteristics and Motions of Stars," led by Dr. Walter Baade, of Mount Wilson Observatory.

TERMINOLOGY TALKS - J. Hugh Pruett

LAST MONTH, in discussing parallax, the simple right triangle was used to illustrate the meaning. But all kinds of plane triangles may be employed in measuring distances by triangulation, terrestrially and celestially, and in practice, of course, an exact right triangle is rarely encountered. Our astronomical examples will serve to illustrate this point.

Geocentric parallax

Let us suppose that the circle in the accompanying figure represents any circumference of the earth with its center at B, and that C is some point on the moon. Sights are taken on C by observers at a and b. Then aCb is the simple parallax obtained from the ends of the base line drawn between a and b. A base line such as this, neither at right angles to the direction to the moon nor covering widely separated points on the earth's surface, is usual to such measurements, except under special circumstances.

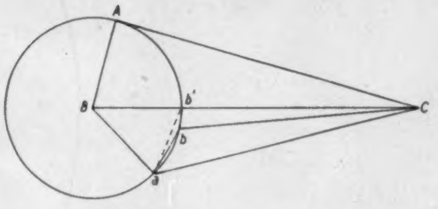
Should the observers sight from a and b', the latter being exactly in line with B and C, so that C is directly overhead, then by a little mathematical manipulation b' may be transferred (on paper) to B and the triangle BaC used. When one station is thus considered at the earth's center, the angle C is usually called the *geocentric parallax*.

Now let our moon shots be taken from b', where our lunar neighbor is in the zenith, and from A, where it is on the horizon. The angle ACB is then the *horizontal geocentric parallax*. The value of the lunar parallax usually given in textbooks refers to the *equatorial horizontal geocentric* type (the third word often omitted for brevity). This means that A is on the equator and AB has its greatest possible value.

This is obviously merely a standard way of expressing the value of the measured distance to the moon, for there are no observatories situated on the equator capable of observing lunar parallax, and in practice the moon's position cannot be measured when it is on or near the horizon, because of refraction by the earth's atmosphere. For practical purposes, therefore, points a and b represent our usual base line, although it is convenient if one observatory can be in the Northern and one in the Southern Hemisphere, such as the Greenwich Observatory in England and the Royal Observatory at the Cape of Good Hope, South Africa. The moon may then be observed near the meridian from the two stations simultaneously.

Heliocentric parallax

For distances to the nearer planets and the asteroids, geocentric parallax measurements may also be made, but as soon as we consider even the nearest star, our earth-bound base lines become too short. To get the longest possible base line for measuring distances to the stars, let C in our diagram represent a star, B the sun, and A the earth when at its mean distance from the sun. Then the angle BCA is the *heliocentric* or *annual parallax* of the star. If AB is drawn one inch long, then BC, the distance to a star that might have a parallax of one second of arc, must be over three miles long. To the nearest star, Alpha Centauri, this dis-



tance would be 4¼ miles on this same scale. The difficulty encountered in measuring stellar distances is appreciated when we think of trying to detect a difference in direction of a point 4¼ miles away as seen from the ends of a line one inch long, or even from a line two inches long, representing the entire width of the earth's orbit, the maximum possible base line.

It is important to set down the definition of stellar parallax as the angular size of the mean radius of the earth's orbit (astronomical unit) as seen from the star. For Alpha Centauri, this angle is 0.761 seconds of arc, corresponding to a distance of 4.3 light-years.

Some celestial distances are:

From earth to moon	1.3 light-seconds
From sun to earth	8.3 light-minutes
From sun to Pluto	5.5 light-hours
From sun to Alpha Centauri ..	4.3 light-years
Across Milky Way galaxy	100,000 l-y.
To the most remote naked-eye object, the galaxy in Andromeda	750,000 l-y.
To the most distant galaxy known	500,000,000 l-y.

Parsec

Earlier (October Talks) we discussed the light-year as a unit of celestial distance. We frequently find astronomers using the term *parsec*. This is the distance to a star which has a heliocentric parallax of one second of arc (1″), and equals 3.26 light-years. The word is an abbreviation combining "parallax" and "second." No known star is as near as one parsec.

The convenience of the parsec concept is that whenever a parallax of a star is given in seconds of arc, the reciprocal of the number is its distance in parsecs. Thus, a parallax of 0″.1 represents 10 parsecs distance; 0″.01 is 100 parsecs, and so forth. As the parsec is a larger unit than the light-year, and lends itself so readily to usual parallax notation, astronomers are using it more frequently all the time, particularly in expressing the great distances across our Milky Way and to other galaxies.

"206,265"

To translate stellar parallaxes into astronomical units, the number of seconds of arc in a radian, 206,265, is a useful quantity. This means that in an angle of one second, the length of the chord or arc (in such small angles they may be considered equal) subtended by the angle is 1/206,265 as long as the radius of the circle in which the angle is subtended. In the case of a star with a parallax of 1″, therefore, the arc is the radius of the earth's orbit, one A. U., and the distance to the star is 206,265 times as great. With such small angles, as already mentioned in the case of parsec above, the distance varies inversely as the parallax, with each parsec representing 206,265 A. U. If the parallax is 0″.5, the star's distance is two parsecs, or 2 x 206,265 A. U. This places Alpha Centauri about 270,000 times as far from the sun as the earth is.

AURORAL PHOTOMETRY

(Continued from page 39)

that observed at 2:20, but as the sensitivity of the photometer was intentionally increased by a factor of two in the meantime, the sky had actually become four times brighter in a period of two hours. However, more interesting than the total increase in the sky brightness are the fluctuations caused by the flashing streamers of the aurora. These fluctuations have already been mentioned as the irregularities noted in the deflection marked STAR. In the absence of the aurora all tracings would have been quite smooth.

An extremely brilliant streamer is noted at 4:41 lasting three quarters of a minute. By 5:20 the auroral glow had spread to the eastern and western horizons and, as can be seen from the tracing ending at 5:38, the activity as well as the total brightness was increasing. For the tracing beginning at 5:55 (nearly midnight) the sensitivity of the photometer was intentionally reduced by one half since the deflections were running off scale. Therefore, from 2:20 to 6:13, the total light of the sky increased 16 times, being magnitude 20.2 per square second of arc at 2:20 and magnitude 17.2 per square second at 6:00. Although many auroral curtains began to form after 6:15, the general light of the sky was beginning to decrease, with evidence of less activity than is shown for the increase.

THE STAR O

By Catharine E. B

In 1910 Halley's comet formed this striking configuration with the planet Venus (lower right). Photograph by Lowell Observatory.

MANY PERSONS, to this day, believe that the Star of Bethlehem was in the nature of a miracle — a vision that appeared to the Magi alone. Others believe it was an actual star, and some think it can be found among familiar celestial objects. But as there isn't anyone today who can prove what it was, each one may think of it as he wishes. Whatever its true nature, the Christmas star is an ideal symbol for what we should feel most deeply at this season.

Basing our discussion here on the belief that the star was of an astronomical nature, we shall consider some of the theories expressed in regard to it.

One might suppose it would be an easy task to reproduce the sky picture at the time of the Nativity, and it would be if it were a matter of searching ancient records to find the unusual that appeared in the heavens at that period, or of computing the movements of the celestial bodies at that time to ascertain if any extraordinary events were taking place in the heavens. Unfortunately, however, we do not know the year in which Jesus was born. In the *New Testament* there is little evidence as to this date, and although various dates have been used from time to time, there is no general agreement among historians. Calendars have changed and other factors only increase the confusion, but we know definitely that Christ was not born in the year 1 A.D.

The Roman calendar of 2,000 years ago had its month based on the phases of the moon, while the year was supposed to represent the period of recurrence of the seasons. There was no week in the Roman calendar, but the months were divided roughly by three days referred to as the kalends, nones, and ides, and the other days were designated numerically backwards from these three. Emperor Constantine introduced the week (used in ancient Eastern calendars since early times) into our calendar in 325 A.D. Other important changes were made around 46 B.C. by Julius Caesar; in 533 A.D. by Dionysius Exiguus; and in 1582 by Pope Gregory XIII. The change that most seriously affected the calculations regarding the birth of Jesus was the one of Dionysius.

He suggested that no longer should the years be counted A.U.C. (*ad urbe condita*)—that is, from the founding of the city of Rome, although the original date used was only legendary. Instead, Dionysius reckoned from the birth of Christ, but he made an error in his calendar computations which has thrown us off at least four and perhaps as many as 11 years.

According to the Gospels, Jesus was born in the days of King Herod, whom Josephus states died within a few days following an eclipse of the moon visible from Jericho, and a few days preceding the feast of the Passover. The dates of eclipses and Passover are contingent with the motions of the moon, and these dates are easily calculated. Probably the eclipse referred to was the one of March 13, 4 B.C., and the feast of Passover was on April 1st of that year. Therefore, the Nativity must have been before this time, perhaps as much as a few years.

The Gospel of Luke provides another key. We are told that Joseph and Mary journeyed to Bethlehem because Caesar Augustus sent forth a decree that a census of the whole world be taken "and all were going, each to his own town, to register." This was to be done for the purpose of tax collection. If we knew the date of this registration, we would know that of Jesus' birth. But again, there is no exact record. Some 20 years ago, however, an ancient inscription was unearthed in Ankara, Turkey, giving a list of the years in which orders were issued for tax collections, and the most feasible date for our purpose would be 8 B.C. But retarded travel and communication in those days might easily have delayed actual collection of taxes by a year or two, and the Nativity might have taken place in 7 B.C. or perhaps 6 B.C. Consensus of opinion makes these the two most likely years.

Does this approximate time enable us to determine what was seen in the sky that the Magi called the Star of the East?

One suggestion is that it might have been a bright meteor, one of the very brilliant objects called fireballs — in the night sky they are most spectacular but their light lasts usually only a few seconds. It would seem more likely, however, that the star of the Magi must have been something less transient. For did not the wise men follow it afar for several months, if they came from the land of Persia, as is generally believed?

A comet is our next possibility. When these vagabonds of the solar system move in near the sun in their elongated orbits they grow very much brighter; when far away they cannot be seen even with our most powerful telescopes. When near the sun and also close to the earth, a comet may become a very spectacular object in

THE MAGI

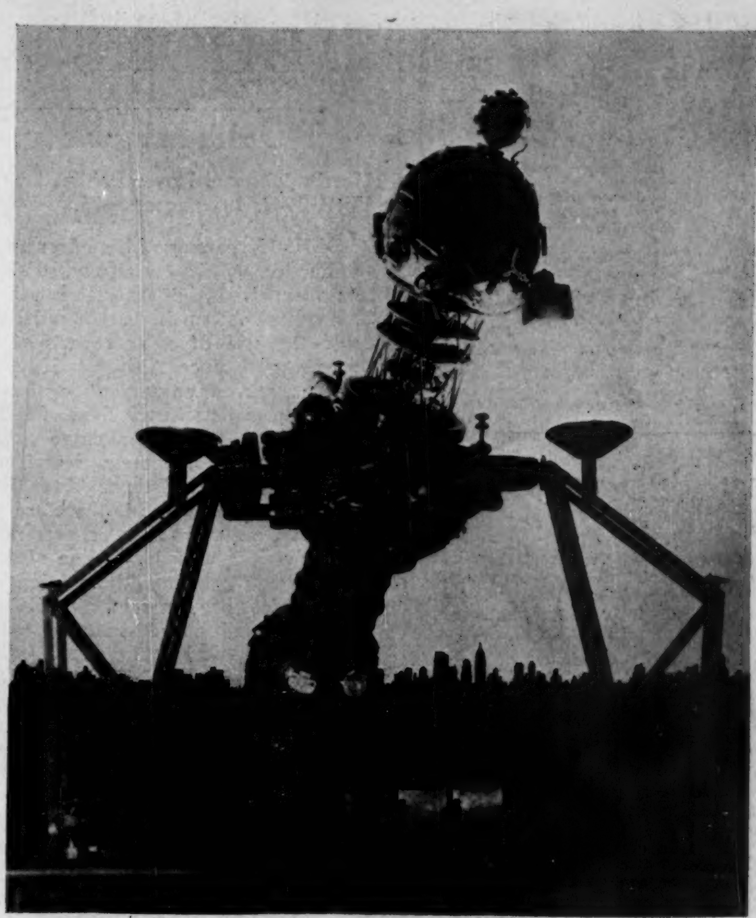
Hayden Planetarium

the night sky. Comets are seen with the unaided eye for a few months at most, although with optical aid such comets as Halley's are visible for more than a year at each return. The Magi, however, had no telescopes and would not have noticed a comet until it became fairly conspicuous. This might have limited the time they had to follow it, and we wonder if they would have seen it all the way to their destination.

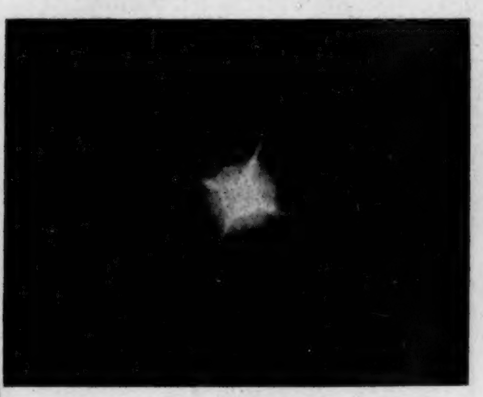
But a spectacular comet attracts much attention, and no doubt would have been recorded in many places in ancient times. Halley's comet was seen in 11 B.C., and there probably was another such visitor in 4 B.C., but these seem respectively too early and too late to have occurred at the time of Christ's birth. Thus we might dismiss comets as explaining the Star of Bethlehem.

Perhaps it was a kind of object which is still a mystery of the skies. From time to time a "new" star shines forth, attains brilliance and then fades quickly, becoming too faint to be observed with the naked eye. This nova is not really a star that has just come into being but an old one that suddenly explodes or in some way bursts into great brilliance. Many times in the course of history a nova has marked an epoch, but we cannot find any record of one occurring at any time near the Nativity. Certainly such an event would have been recorded, and especially so if the star was a supernova and might easily have been intrinsically 100 million times as luminous as the sun. Such a supernova, at a distance of 100 light-years, would be brighter than the full moon. A nova observed in 1604 by Kepler, a foremost astronomer of his time, gave birth to the suggestion that the star of the Magi might have been such an object.

When Kepler first observed the supernova of 1604, he was studying something else uncommon, a close assembling of the planets Saturn, Jupiter, and Mars. Saturn is the slowest moving of the three, requiring almost 30 years to go around the sun; Jupiter takes nearly 12 years; and Mars nearly doubles the time the earth requires — the ruddy planet has a period of revolution of 687 days. With these speeds, Jupiter passes Saturn once about every 20 years. In passing, planets are said to be in conjunction even though they may be separated considerably north or south of each other.



By means of projectors such as this one in the Hayden Planetarium, the appearance of the heavens 2,000 years ago may be reproduced, including the approximate positions of the planets.



A nova, temporarily the brightest star in its portion of the heavens.

Near the close of 1603, Kepler watched just such a conjunction of Jupiter and Saturn. Before the two were very widely separated, Mars, the speedster of the three, passed them both near the beginning of October, 1604. On the 10th day of that month, the supernova of 1604 was discovered, to be seen by Kepler a week later. It was observed not far from the three planets, and became brighter than Jupiter. Kepler knew that similar gatherings of the planets had taken place in the year 7 B.C., and he proposed that a new star might have been seen near Jupiter and Saturn to be interpreted as a sign in the sky. It is true that in February, 6 B.C., Mars formed a triangle with the other two planets, but the sun was too close to this configuration for it to have been observed.[1]

The gathering of the planets in the constellation of Pisces, the Fishes, sacred to the Jewish people, was undoubtedly taken as of great significance to them. Also, they were of the belief that Saturn was their ruling planet, and so they had two justifiable reasons for thinking that the conjunction of Jupiter and Saturn was a portent of a remarkable event to take place among the Jews. This alone may have been the sign the Magi were waiting for, or perhaps a nova, as suggested by Kepler, started them on their way to Jerusalem.

After the sun had passed the configuration of Mars, Jupiter, and Saturn in late February, 6 B.C., Mars moved away from the others but Venus came into the picture. Considering its brilliance and its relation to these planets in the "house of the Hebrews," the brightest of the planets might well have been taken as the sign of the Nativity.[2]

Thus, there are some possible astronomical explanations as to the true nature of the Christmas star: a brilliant meteor or fireball, a comet, a nova or supernova, and some uncommon configurations of the planets. More important, perhaps, than the explanation of the star, is its value as a symbol of admirable and exalted ideals.

[1]See Astronomical Anecdotes, R.K.M., *Sky and Telescope*, III, 2, 15, December, 1943. — ED.

[2]See "Venus as the Christmas Star," Jesse A. Fitzpatrick, *Sky and Telescope*, I, 2, 11, December, 1941. — ED.

BOOKS AND THE SKY

TIME, KNOWLEDGE, AND THE NEBULAE

Martin Johnson. Dover Publications, New York, 1947. 189 pages. $2.75.

SOME 15 years ago Milne first proposed his kinematical relativity, which differs from Einstein's special relativity of 1904 somewhat as the use of radar differs from the use of a surveyor's chain in measuring distance. Although Milne's theory has stirred up violent controversies among specialists in the field of relativity and cosmology, the average scientific reader has unfortunately remained unaware of its very existence. **Time, Knowledge, and the Nebulae** is therefore particularly noteworthy as a short, readable book giving a brief description of the two relativities, together with mention of the cosmologies of Einstein, de Sitter and Lemaitre, and a well-rounded study of their philosophical implications. Dr. Johnson, with many others, believes that Milne's approach represents a profound change in the philosophy of physics, this being due mainly to more careful analysis of our concept of time. Its fundamental nature can be seen from the fact that Newton's laws of motion and gravitation and Einstein's special relativity are all derived **ab initio** by Milne.

The kinematical relativity has been criticized as an attempt to deduce the laws of nature without recourse to observation. In fact, Milne builds a rigorously logical postulate system very like Euclidean geometry (which has not recently been criticized for deducing properties of triangles without recourse to observation!), based upon operational definitions of distance and time, together with the major premise (the "cosmological principle") that two "equivalent" observers must have the same view of the universe. Time is defined as being measured by any device (a "clock") which assigns successive numbers to events in the order in which they are experienced by an observer. Distance is then defined in terms of the time required for a light signal, assumed to have a universally constant velocity, to travel from the observer to a distant point and back, the principle of radar ranging.

Of course Milne's purposely vague description of a clock does not insure that the units of time it reads will be "constant" in length, but he proceeds to show that three or more observers can regraduate their clocks in only **two** ways, such that their observations will be consistent. From these two possible graduations of their clock dials, observers will read **two different kinds of time,** with rates which seem from present observations to differ by one part in two billion. He then shows that a pendulum and the motion of earth, moon, and planets keep one kind of time, "dynamic" time, and that atoms emitting radiation of a certain frequency, or disintegrating radioactively at a certain rate keep the other, "kinematic" time. The slightly changing rate between these two kinds of time results in the red shift of the spectra of distant spiral nebulae, the rate of our atomic clocks having speeded up during the years required for light to travel from these distant galaxies to the earth.

Dr. Johnson develops two basic themes in his book: the first concerns **the nature of time,** which leads to a discussion of various philosophies and of the many contexts in which "time" is used in physics. The author pursues this theme with such vigor that the reader is led to expect a different time-scale for each of the meanings of time in physics, although only the two mentioned above, "dynamic" and "kinematic," seem to be significantly different. Some readers may feel that this philosophical discussion is too brief, particularly where the author mentions only in passing the widely different points of view of Kant, Spinoza, Mil[illegible]egel, Bertrand Russell, Whitehead, [illegible]r, Dingle,

and Eddington. It is inferred from this survey, largely from the indeterminacy principle of quantum mechanics, that causality should be eliminated from the concept of time and replaced by the more general "functional dependences," which merely record relationships between phenomena without specifying cause and effect.

The second and more important theme is the development of the "principle of communicability," which is Johnson's premise out of which Milne's theory can presumably be derived, in particular the cosmological principle and the assumption of a universally constant signal (light) velocity. The principle of communicability states that it must be possible to communicate experience (the laws of physics) intelligibly from one observer to another. Otherwise, Johnson reasons, scientific data would only have meaning to one observer, and no objective body of science could be accumulated. A more satisfactory justification of this premise is the success of deductions therefrom; various observers on the earth have so nearly the same viewpoint that they are virtually but one observer in the universe, and it seems unlikely that we will have occasion in the near future to check the principle of communicability directly with observers in other galaxies.

The recording of functional dependences, which are internally consistent and communicable to a distant observer, appears to the author to be the goal of physical science, rather than isolating sequences of "cause and effect."

Brief appendices on various fields of physics, mechanics, the electron theory, thermodynamics, spectroscopy, electromagnetic theory, and observational cosmology, and a section on the mathematics of group theory, will help to fill in the background of the non-specialist reader. However, the book is scarcely at the popular level, nor is it consistently introductory in style. For instance, Johnson gives an elementary and exceedingly clear description of wave motion, but later expects his uninitiated readers to follow the solution of functional equations, and in another place, to understand equations of general relativity in which the symbols are not adequately defined. But the most glaring omission from the point of view of the non-specialist reader is the lack of diagrams, which could have been used to make much of the argument clearer and more easily grasped.

On the technical side, it is unfortunate that Johnson scarcely mentions geologic time, time in evolution, and Dunne's theory of time based upon human consciousness of "now." More serious in the presentation of the kinematical relativity is the omission of reference to accelerated reference systems and to Hubble's surveys determining the space distribution of the extragalactic nebulae.

For the serious reader, **Time, Knowledge, and the Nebulae** poses fascinating problems. It points to new possibilities in the interpretation of data, for instance, the predicted increase in angular momentum and the "gravitational constant" with time. It may well take its place with Bridgman's **Logic of Modern Physics** and Karl Pearson's **Grammar of Science** as a guide to scientific philosophy.

THORNTON L. PAGE
Yerkes Observatory

Planetarium Notes

ADLER PLANETARIUM

900 E. Achsah Bond Drive, Chicago 5, Ill. Wabash 1428

Schedule: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m.

Staff: *Director,* Wagner Schlesinger. *Other lecturer:* Harry S. Everett.

December: THE STAR OF BETHLEHEM. We go back nearly 2,000 years to see celestial events in Palestine at the time of the first Christmas as possible explanations of the Christmas star are discussed.

BUHL PLANETARIUM

Federal and West Ohio Sts., Pittsburgh 12, Pa. Fairfax 4300

Schedule: Mondays through Saturdays, 3 and 8:30 p.m.; Sundays and holidays, 3, 4, and 8:30 p.m.

Staff: *Director,* Arthur L. Draper. *Other lecturers:* Nicholas E. Wagman, J. Frederick Kunze.

December: STAR OF BETHLEHEM. Visitors are taken back to Palestine's skies of 2,000 years ago, to view the dramatic possibilities of the first Christmas star.

January: WINTER STARS.

FELS PLANETARIUM

20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Rittenhouse 3050

Schedule: 3 and 8:30 p.m. daily except Mondays; also 2 p.m. on Saturdays, Sundays, and holidays. 11 a.m. Saturdays, Children's Hour (adults admitted).

Staff: *Director,* Roy K. Marshall. *Other lecturers:* I. M. Levitt, William L. Fisher, Armand N. Spitz, Robert W. Neathery.

December: STAR OF BETHLEHEM. The traditional Christmas demonstration will portray the skies at the time of the birth of Jesus, and will make its contribution to the spirit of the season in music and drama.

January: CALENDARS AND THE SKY.

GRIFFITH PLANETARIUM

P. O. Box 9787, Los Feliz Station, Los Angeles 27, Cal., Olympia 1191

Schedule: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m. Extra show on Sunday at 4:15 p.m.

Staff: *Director,* Dinsmore Alter. *Other lecturers:* C. H. Cleminshaw, George W. Bunton.

December: THE STARS OF WINTER. The outlines of the mythological figures are projected in the heavens as an aid in learning the principal stars and constellations of the winter sky.

January: A PREVIEW OF THE 1948 SKY.

HAYDEN PLANETARIUM

81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500

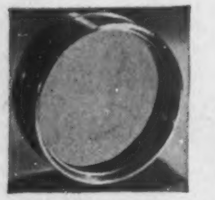
Schedule: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.

Staff: *Honorary Curator,* Clyde Fisher. *Chairman and Curator,* Gordon A. Atwater. *Other lecturers:* Robert R. Coles, Catharine E. Barry, Shirley I. Gale, Edward H. Preston.

December: THE STORY OF CHRISTMAS. Because of its timeliness and timelessness, the traditional Christmas program is favored at the planetarium. The Wise Men's star will be discussed, with projection and Christmas music.

January: A TRIP TO MARS.

EXCEPTIONAL VALUES



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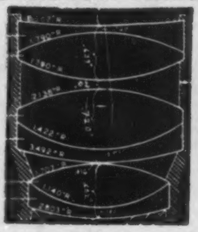
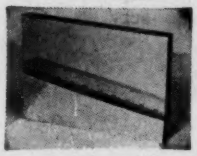
Harry Ross Series of "Doublestar" Refractors, 3" aperture (75mm), 40" focal length (1000mm). An air spaced lens, strain free mounted in a smooth aluminum finished satin-black barrel. This lens is an exclusive Harry Ross product. It has a money back guarantee which states, "This lens will meet any and every test you may devise for it as an astronomical objective." It is 20 years since a lens of this quality has been available. Our production is limited. Order early. Postpaid $60.00.

Achromatic Telescope Objectives in all sizes up to 6" diameter to order. Same optical guarantee as with our 3" lens. Write us.

3-Element Achromatic Eyepiece



Six lenses! Finest eyepiece ever made anywhere. Our greatest buy to date. Made of three separate achromatic elements (illustrated). All outside surfaces fluoride coated. In focusing mount. 1-13/16" (43mm.) clear aperture, flat field to edges. Focal length 1¼" (32mm.) (8X). 69° angle. Outside diameter of mount 2⅛" (54mm.) Each $15.00 plus postage. Quantity definitely limited. Lenses only for above, $9.00 per set.



Front Aluminized Mirror

Finest quality plate ground to ¼ wave flatness and aluminized with a hard, almost scratch-proof coating. Nothing finer for use as a diagonal in place of prism. These "Flats" can also be used to reflect ultraviolet and infra-red light with minimum loss. Great saving if used in place of prisms in Porro #2 system.
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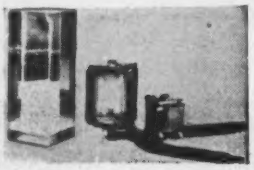
Prism—Light Flint Glass

Fluoride coated, in mounting of aluminum-magnesium alloy, with ballbearing swivel. Meets most exacting requirements. 1-5/16" by 1¼" face. Suitable as diagonal for reflectors up to 8", also as star diagonal on refractors. These prisms can be used to make Porro's system #2 erector. Price $3.75.

PRISMS

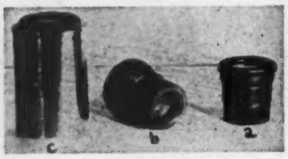


Water - white crown glass of excellent quality. Government inspected and accepted. No chips or roughs. 45-90-45 degrees in mounts. Sizes:
⅞" x ⅞" (23mm.) .... @ .75
1⅝" x 1-3/16" .... @ $1.50
Back silvered unmounted, size:
4" (102mm.) x 1½" (39mm.) ... @ $3.00

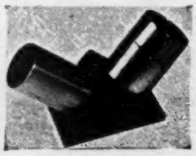
PORRO PRISM

Porro prisms for 6x30 binoculars. Perfect 50c each. Imperfect prisms for 7x50 binoculars 50c each.

Achromatic Kellner Eyepiece M-1



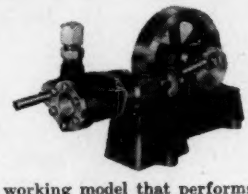
With a high eyepoint, completely assembled. Ready to use in telescopes, binoculars, microscopes, finders, spotting 'scopes or wherever a very superior wide field ocular of fine definition and great light gathering qualities is required. Both eye and field lenses are achromatic and fluoride coated.
(a) E.F.L. 0.785" (12.5X). O. D. ⅞" .. $5.00
(b) With crosshair $6.00
(c) Bushing to fit 1¼" tube ...... $3.00 extra
* Other diameter tube .... $4.00 extra



Star Diagonal

Fits standard 1¼" tube, takes 1¼" eyepiece. Precision quality throughout. Prism is fine quality fluoride coated. Finished in brass and black. Makes for convenient overhead viewing of stars with refractor. $12.00.

STEAM ENGINE



A real working model completely assembled and ready for steam. Strongly made of brass, bronze and iron. A practical working model that performs and operates like a real steam engine. Made to exact scale. Educational, instructive, entertaining and decorative. For students, experimenters, display. Can be employed as aerating pump for tropical fish tank. Many other uses. Specifications: Bore 9/16", Stroke 11/16", length of base 6", height 3", weight 2 lb. Finished in red enamel with brass trim. With 15 lb. pressure engine delivers almost ¼ H.P.
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Double Achromatic Lens System

All outside surfaces fluoride coated. 2½" (64 mm) f.l., mounting O. D. 1-3/16" (30 mm), clear aperture ⅞" (23 mm). Suitable for inverter with our eyepiece; as an excellent corrected magnifier (4 power) and as a projection lens for 2x2" slides.
Each $3.50.

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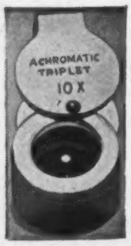
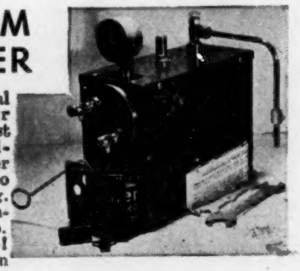
Genuine Polaroid variable density device. 2⅞" diameter. Complete new stock. Postpaid, $2.35.



Achromatic Loupe

1" f.l. (10x), ⅝" diameter, ½" thick. Made by American Optical Co. to Hastings formula. Spherically and chromatically corrected like the finest microscope lens. Remarkable for wide, flat field, brilliant image, greater working distance. Unmounted $6.00. Mounted in aluminum, $7.50.

STEAM BOILER



Miniature real steam power boiler of cast bronze endplates silver soldered to brass tubing. Tested to withstand 300 lb. pressure. Safe! Enclosed in sheet iron housing. Uses one or two "Sterno" cans for heat. Dimensions: 8" x 8" x 3½". Weight 4 lb. Fittings include safety valve, pressure gauge, throttle; connecting steam pipe of copper with oil vent; wrenches. Natural rolled iron, bronze, brass and enamel finish. One pint of water will run 2 hours, giving steady volume of steam at 15 lb. pressure. Price $22.50.

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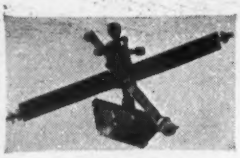
Make a high power reflecting telescope from fully finished precision optical parts. Mirror and diagonal both hard aluminized plus 3 lenses for high power eyepieces.
3" dia. 39" f.l. mirror kit $6.00
4" dia. 56" f.l. mirror kit $10.00

Diagonal For Reflecting Telescope

4 ARM



Prism in metal spider mount to fit 5-6-7 or 8" tube. Light flint glass prism, fluoride coated, 1¼"x1¼" face. Connecting arms present thin edges to path of light. Prism centering easily adjusted to slight differences of tube diameter by lock washers. Complete, $10.00 plus postage. Specify your tube size.

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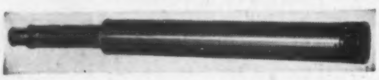

15X finest precision made, achromatic optics, fluoride coated 7½" f.l. objective, 2½" f.l. inverter and ¾" f.l. Kellner eyepiece (without crosshairs) afford color-free field flat to the edge. Two sections, entirely of brass, give perfect alignment. Price complete, $22.50.

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EDITED BY EARLE B. BROWN

MASS PRODUCTION OF MOUNTINGS BY AMATEURS

FOR MANY YEARS, the Optical Division, Amateur Astronomers Association, New York City, has conducted classes in mirror making at its workshop in the Hayden Planetarium. To date, more than 300 mirrors have been made in these classes. Unfortunately, although the Optical Division possesses a small machine shop, its facilities for the construction of the mechanical parts of a telescope are insufficient to accommodate a large class.

Harvey E. Parry, one of the members of the 1945-46 class, under the tutelage of Allyn J. Thompson, recognized this deficiency, which has resulted in many of the mirrors produced being relegated to attics and basements, and realized that his own connection with the Stuyvesant High School (where he is in charge of the science shop) furnished a possibility of alleviating the difficulty. Following is his story of what was done in turning 13 mirrors into useful instruments. (See front cover.)

WITH NO THOUGHT of becoming trail blazers in the field of amateur telescope making, the 1945-46 mirror-making class of the Optical Division has set a precedent in the production of complete telescopes.

The writer, sensing the probable result of a season's labor being only an unmounted, unusable mirror, offered to serve as leader in securing the use of the facilities of his science shop at the Stuyvesant High School, New York City. Fred Schoenberg, the principal, was gracious in his approval, as was the Night School Division of the Board of Education, which issued the permit.

The shop equipment at our disposal included seven lathes (both South Bend and Ames Precision), two drill presses, a milling machine, a metal-cutting band saw, a power hack saw, a spot-welding machine, a break and shear, a 36″ wood band saw, and a power circular saw, together with benches, vises, and miscellaneous hand tools.

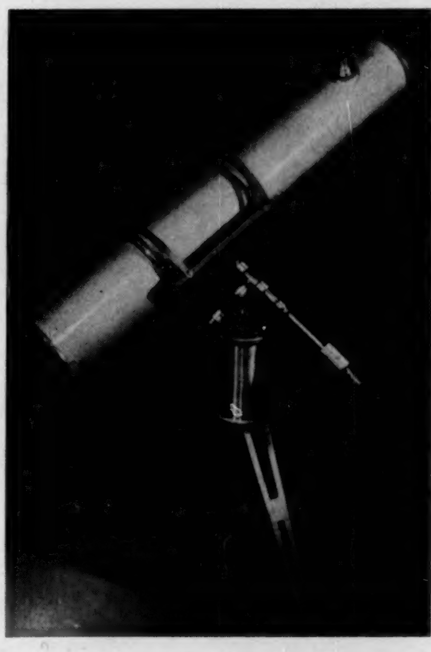
Thirteen class members signed up for the group. Some admitted that they knew nothing whatsoever about the job. Some had had school shop experience. One had considerable layout experience and skill. One man became our filing expert; he was the most persistent file hand I have ever seen. Then we had a washing and sandpapering wizard, and there was certainly a lot of both to be done! The sessions were conducted in the evening, three hours to a session.

The first meeting after signing up brought out two most important decisions. The first was that a single standard design should be used, with no substitutions permitted in pattern or arrangement. This decision greatly reduced the work to be done. The second resolve was that all purchases and funds be in charge of a single committee. This permitted economy which would not have been possible if each man had made his own purchases. It was decided that the work should be done on a production basis; that is, each man performed certain operations on all or a large number of the parts to be made, rather than each man doing all the work on a single telescope. This made for considerable economies in time.

The matter of choice of design was simply settled. Mr. Thompson had his own design (**Making Your Own Telescope**, Allyn J. Thompson, Sky Publishing Corporation, 1947) and a prototype telescope was at the planetarium. It is pleasing, practical, sufficiently complex, and inexpensive. The equipment at our disposal made some minor rearrangements of detail advisable, but in the main we followed Mr. Thompson's design.

Rolled plywood tubes were obtained in the proper diameter and length from a plywood manufacturer. The four tube rings were made of ⅞″ laminated birch. They were cut into squares from large sheets. A piece of stock was mounted on a large face plate, four bolts being placed on this to line up with holes carefully spotted on diagonal lines in each corner. A parting tool was used to cut out the center with minimum waste, since the center pieces were needed for the mirror cell mounts and the tripod column ends. This face plate setup also made it possible to cut a rabbet on half of the circles, for use as end rings on the tubes. The outside cut was a simple turning job. The outside of the rings was finished on a disk sander while a drum sander was developed to run on a lathe to finish the inside. Getting out 52 of these, which measure about 10″ outside, is quite a job. It was fun, however, to see the pile grow and to speculate when we would assemble them and just which would go on what tube, even though they were all alike.

The saddles and cradles were made of



One of the telescopes completed by Mr. Parry's group. This and the front cover photograph by Anderson, Stuyvesant High School Photography Club.

the same stock. The latter were band sawed and then sanded on the same diameter drum which sanded the inside of the center rings, thus giving a good fit. The bases were routed on the circular saw, which was carefully set with stops so that the supports fitted neatly and firmly.

One squad was assigned to the production of the tripod leg units. The legs were made of T-iron. Each leg required two pieces of iron with three taper cuts at the bottom to give a slenderizing effect where they joined. This was done on the milling machine, with final finish by hand filing. A fishplate, acting as a tie, was made for the center and also for the bottom; these were spot-welded into position, giving rigidity. The foot itself was square stock, taper-turned with a rounded point to provide a grip without destructive effect on floors or pavements. These feet were riveted to the legs.

The top ends of the legs were spread and bored to attach to blocks at the base of the center post. These serve as a hinge, making the legs collapsible. Slotted strips hinged to the legs a third of the way from the top, bolted together with a single bolt and wing nut, make a satisfactory cross-tie to give the tripod rigidity. Looking back on this part of the job, I feel that the legs would have proven steadier if they had been attached to the upper end of the central column with the horizontal brass ties secured to the bottom of the column. The loss of facility in use caused by this leg-lengthening would be apparent only at the zenith. The additional weight would be an advantage. In either case, a casting having suitable hinge blocks would be better than the wooden blocks we used.

The equatorial mount unit was constructed of standard brass pipe fittings and babbitt. The central column was made from two of the tube ring centers. These were bored on the lathe, using a block as a drill pad against the tailstock while the expansion bit was held in the three-jaw chuck with the square shank of the bit extending inside the chuck jaws. Twenty-six 1½" holes, ⅞" deep, bored through birch plywood, can hardly be classed as fun. A piece of 1¼" iron pipe was run through these washers. A 45° street elbow was used at the upper end and an iron lock nut held the shaft tight and secure. The aluminum tubes for the columns were purchased as "shorts" at a war surplus store for 55¢ each. Steel wool gave them a satisfactory finish.

The really tricky job was in the T, which was screwed to the street elbow. This serves as a bearing and provides, with the elbow, the 45° inclination which approximates the New York latitude. The thread was rough-cut out of the straight end of the fitting. The roughened end was carefully tinned to aid in the bond between the brass and the babbitt. The link between the floor flange attached to the 'scope saddle and the T was a piece of 1" brass pipe, 12" long, threaded on both ends. A special mandrel with tapered sliding washers was prepared on which to center these pipes. The pipes were reamed on both ends, mounted on the mandrel, placed between centers, then given a very slight taper and made perfectly round.

The nipple (we used stock lengths to considerable advantage) was given a coat of bone black and oil, centered in the T,

gasketed to prevent loss of fluid metal, and the side outlet of the T was placed about 45° to the horizontal. When poured and set, the angle was reversed and the other end poured. The slight taper was sufficient to free the core or central shaft with a single blow of a soft-face hammer. At the lower end of this nipple we attached a reducing coupling and added a smaller pipe to give leverage to the counterbalance weight.

Richard S. Luce, of the Optical Division, had patterns for the eyepiece saddle and adjusting washer, and from them we had aluminum sets cast. The telescoping tubes for the eyepieces were purchased at a metal supplier. They were cut to length, fitted, and polished on the speed lathes. All the other fittings were screwed to short lengths of pipe and dressed to a satisfactory finish.

The painting job was handled in much the same manner as the machine work. It happened that the group included one who is an artist and a practical painter, too, so that the whole job from shellac and primer coat to body and enamel was turned over to him. And a good job he did, too.

In the way of cost, we felt that we got a very good buy for just under 30 dollars each. This cost included small drills, hack-saw blades, and two milling cutters. The members of the group provided about five pounds of lead each.

An estimate of the time spent would be difficult to give accurately. One of the members became a father during the production. Another was out of the city on business for a while. The one junior member had school demands which made his attendance uncertain. We averaged 10 persons per three-hour session for 21 evenings giving an approximate average time of 48½ man-hours per telescope.

We do not feel that we did a perfect job. There is no doubt that if we started again, we would cut many corners, adding materially to appearance and practicability, to say nothing of reducing the time of production. We do feel glad that we had a vision of completion, faith in ourselves, and the "up-and-at-'em" urge to make our mirrors usable. For more exact details and dimensions of the mount we refer you to Mr. Thompson's book.

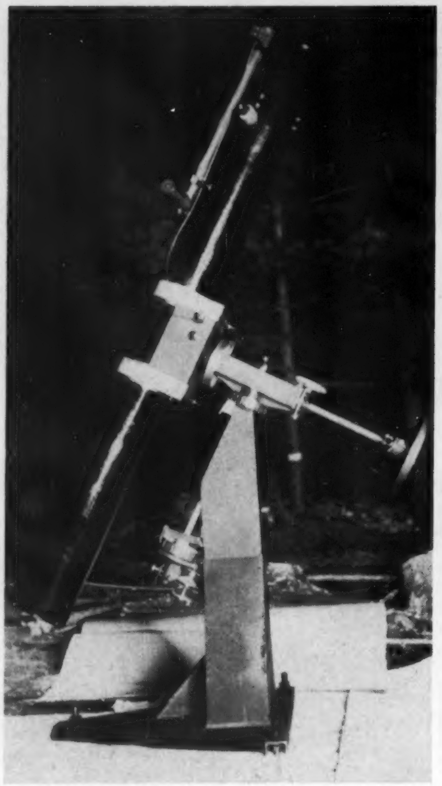
The group members were Julius Blecher, J. E. Boughtwood, Ben F. Clark, A. B. Ettlinger, Philip Friedler, Joseph Glatz, Thomas J. Gorman, Arthur L. Lehman, Harry J. Moser, Marcus Osk, Maurice Pellaton, J. Ralph, and the writer.

HARVEY E. PARRY
51 West 105th St.
New York 25, N. Y.

A Swedish Reflector

It might be of some interest to amateur astronomers in America to see a picture of an instrument built by two Swedish amateurs. I am enclosing a picture of it and you may use it for publication if you so desire.

The instrument was designed and built by A. Wretman and the writer, both living in Krylbo, Sweden. The constructional drawings and calculations were made by the writer, who also made the mirrors, while the mechanical parts were made by



A telescope made by Swedish amateurs. At 60° north latitude the polar-axis inclination is very noticeable.

Mr. Wretman, who is the most experienced astronomer of the two.

The instrument is a 6-inch Newtonian, the mirror having a focal length of 75". Five eyepieces in conjunction with several Barlow lenses give magnifications from 45x to 500x. The instrument (mechanical part of it) is entirely constructed of steel, iron, and aluminum. The pedestal is of 2½" U-iron, which is bent to latitude at the upper end. A heavy iron pipe was welded inside the U-iron, and in this pipe the polar axis was centered, and melted bearing metal was poured around it to form a bearing 10" long. An upright U-iron supports the pedestal at the top and several pieces of U-iron are welded on as braces. The entire pedestal is covered with sheet iron to give it a more compact appearance.

The instrument is equipped with graduated circles, giving readings to within three minutes of time. Slow-motion gears in right ascension and declination are provided. A separate gear box with motor is coupled to the shaft of the slow-motion hand control unit when taking photographs.

L. S. HEROU
Krylbo, Sweden

OBSERVER'S PAGE

Greenwich civil time is used unless otherwise noted.

BESTER'S COMET TO BRIGHTEN

Four comets have been found this year by M. Bester, of the Harvard Observatory's southern station at Bloemfontein, South Africa. The last of these, Comet Bester IV (1947k), is at present moving northward from the southern skies. It will be near the sun in the sky at the time of perihelion passage, February 16th, when its distance from the sun will be about 70 million miles. Afterward, favorably situated in northern skies, and approaching the earth to within 70 million miles early in April, the comet may become bright enough for naked-eye observation. Magnitudes "4" in the adjoining table are estimated on a fourth power of the distance law; magnitudes "6" on a sixth-power law. The ephemeris is computed by Dr. Leland E. Cunningham, University of California at Berkeley.

1947 U.T.		R.A. h	m	Dec. °	′	Mag. "4"	"6"
Dec.	1	23	31.1	−53	28	8.1	7.2
	9	22	48.7	−50	36	7.9	6.8
	17	22	18.3	−47	14	7.6	6.4
	25	21	56.3	−43	51	7.4	6.0
Jan.	2	21	39.7	−40	35	7.1	5.5
	10	21	26.5	−37	28	6.7	4.9
	18	21	15.0	−34	25	6.3	4.3
	26	21	04.5	−31	20	5.9	3.7
Feb.	3	20	54.2	−28	04	5.5	3.1
	11	20	44.0	−24	24	5.2	2.7
	19	20	34.0	−20	07	5.0	2.5
	27	20	24.4	−14	49	5.0	2.5
Mar.	6	20	14.9	− 8	03	5.0	2.7
	14	20	04.7	+ 0	59	5.1	2.9
	22	19	51.6	+13	27	5.1	3.2
	30	19	30.9	+30	23	5.2	3.5
Apr.	7	18	50.5	+50	26	5.5	4.0

OCCULTATION PREDICTIONS

December's long nights provide ample opportunity for observing and timing lunar occultations. Attention is called particularly to 13 and 14 Tauri, two stars close to the ecliptic which are favorably occulted on the night before Christmas. Brighter stars are 67 and Kappa Tauri, which are occulted in rapid succession early the following evening, but only for observers in the eastern states. At the end of the month, the bright star Eta Leonis is occulted under circumstances favorable at all stations for which predictions are made.

December 3-4 **46 Leonis** 5.7, 10:29.4 +14-24.6, 21, Em: **A** 10:58.5 −2.3 +0.1 263; **B** 10:55.6 −2.0 −0.2 270; **C** 10:39.6 ... ... 234; **D** 10:42.0 −2.6 +1.1 253; **G** 9:53.0 −1.0 +2.6 248; **I** 9:41.4 −0.6 +3.1 241.

6-7 **46 Virginis** 6.1, 12:57.9 −3-05.0, 24, Em: **A** 9:10.8 −1.1 −1.2 273; **B** 9:13.0 −0.9 +0.9 283; **C** 8:59.2 −1.2 +2.6 252; **D** 9:05.8 −0.8 +1.4 273; **E** 8:49.7 −0.6 +3.1 243.

6-7 **48 Virginis m** 6.5, 13:01.2 −3-22.7, 24, Em: **A** 11:08.3 −0.8 −1.1 329; **B** 11:03.6 −0.6 −1.3 336; **C** 11:06.5 −1.2 −0.6 311; **D** 11:01.2 −0.9 −0.7 321; **E** 10:50.6 −1.0 +0.3 295; **F** 10:28.5 −1.8 +3.5 242.

18-19 **Tau Aquarii** 4.2, 22:46.8 −13-52.4, 7, Im: **G** 2:24.4 −1.3 −0.5 70; **H** 2:22.3 −2.9 −1.1 97; **I** 2:12.9 −1.3 +0.2 59.

24-25 **13 Tauri** 5.5, 3:39.3 +19-31.9, 13, Im: **A** 6:46.4 −0.6 −1.2 88; **B** 6:42.3 −0.7 −1.0 78; **C** 6:48.8 −0.7 −1.8 104; **D** 6:39.9 −0.8 −1.2 87; **E** 6:32.7 −1.3 −1.8 103; **G** 5:54.3 −1.3 +0.8 55; **H** 5:38.8 −2.6 −0.5 97; **I** 5:41.4 −1.2 +1.3 51.

24-25 **14 Tauri** 6.3, 3:40.7 +19-29.9, 13, Im: **A** 7:30.1 −0.1 −2.3 115; **B** 7:23.9 −0.3 −1.9 105; **C** 7:40.7 +0.3 −4.1 139; **D** 7:26.2 −0.3 −2.4 117; **E** 7:37.5 ... ... 153; **G** 6:37.3 −1.5 −0.8 90; **I** 6:24.0 −1.7 −0.3 88.

25-26 **67 Tauri** 5.4, 4:22.3 +22-04.8, 13, Im: **A** 21:50.7 −0.3 +1.3 87; **B** 21:54.4 −0.2 +1.5 82; **C** 21:45.2 −0.2 +1.2 88; **E** 21:47.5 +0.3 +1.3 72.

25-26 **Kappa Tauri** 4.4, 4:22.2 +22-10.5, 13, Im: **A** 21:51.4 −0.1 +1.6 68; **B** 21:56.2 0.0 +1.7 62; **C** 21:45.8 0.0 +1.5 69; **D** 21:53.4 +0.1 +1.7 59; **E** 21:50.7 +0.4 +1.6 53.

30-31 **Eta Leonis** 3.6, 10:04.4 +17-01.3, 19, Im: **A** 5:45.7 −1.4 −0.4 105; **B** 5:46.0 −1.3 +1.0 93; **C** 5:38.8 −1.3 −0.1 119; **D** 5:37.4 −1.1 +0.7 103; **E** 5:24.1 −0.9 +0.4 115; **F** 5:22.7 −1.0 −1.6 152; **G** 5:29.4 +0.1 +2.4 64; **H** 5:09.6 0.0 +0.5 110; **I** 5:27.8 +0.3 +2.3 62. Em: **A** 6:58.2 −1.5 −0.8 305; **B** 6:53.8 −1.3 −1.0 315; **C** 6:52.6 −1.7 −0.1 290; **D** 6:47.5 −1.4 −0.5 304; **E** 6:31.8 −1.3 +0.4 286; **F** 6:10.6 −1.0 +2.4 245; **G** 6:11.9 −0.6 −0.6 331; **H** 6:05.7 −0.3 +0.8 281; **I** 6:07.5 −0.5 −0.5 331.

30-31 **32 Leonis** 6.1, 10:19.0 +15-14.6, 19, Em: **F** 15:00.9 −0.2 −1.6 304; **G** 14:16.0 −0.5 −2.0 317; **H** 14:37.0 −1.2 −1.4 283; **I** 14:12.7 −0.8 −1.7 303.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, GCT, a and b quantities in minutes, position angle; the same data for each standard station westward.

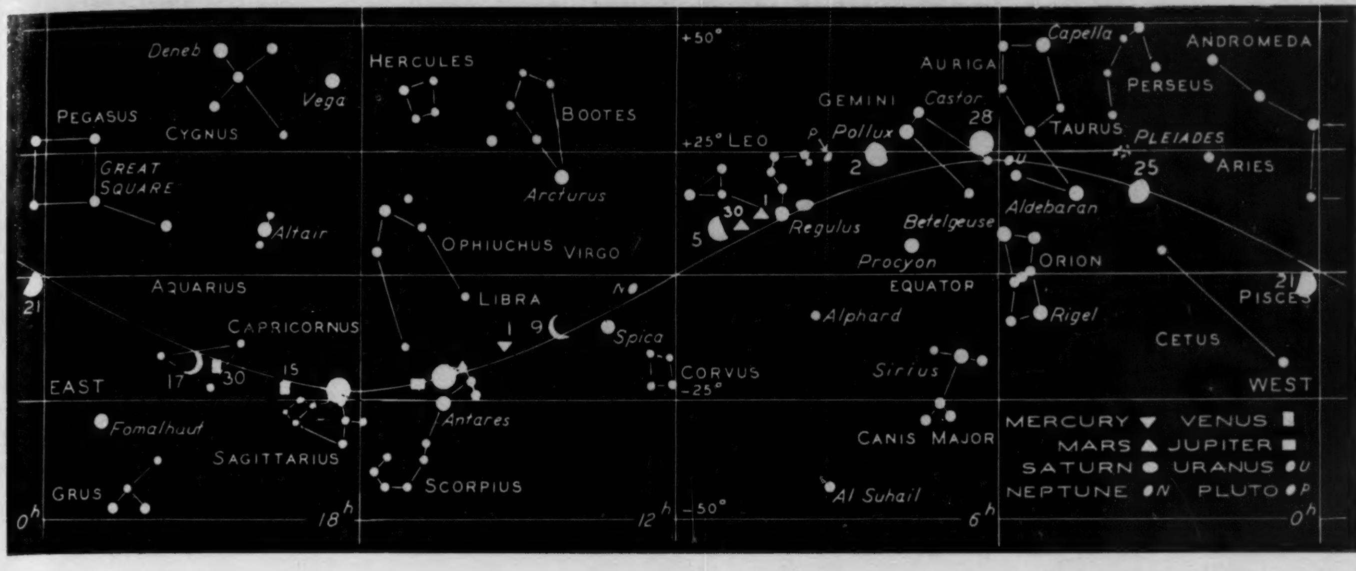
Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +30°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0
I +123°.1, +49°.5	

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard time.

MINIMA OF ALGOL

December 1, 3:06; 3, 23:55; 6, 20:44; 9, 17:33; 12, 14:22; 15, 11:12; 18, 8:01; 21, 4:50; 24, 1:39; 26, 22:28; 29, 19:17. January 1, 16:06; 4, 12:55.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury may be easily viewed in the morning sky the first week of December, rising more than an hour before the sun. Greatest elongation occurred on November 22nd, but conditions are favorable for Mercury to be followed for three weeks after that date. The planet's magnitude is —0.5.

Venus is conspicuously bright in the southwest. It sets about 1¾ hours after sunset, and may now be seen in a completely dark sky. Telescopically, the planet is nearly 12″ in diameter and 90 per cent illuminated.

Earth arrives at heliocentric longitude 270° at 16:43 on December 22nd. Winter commences in the Northern Hemisphere and summer in the Southern.

Mars rises 5½ hours after the sun and is now a prominent object of about zero magnitude. In early December it will be to the east of Regulus, Saturn being a greater distance west. Mars slows down considerably in its eastward movement as retrograde motion commences next month. The moon will be in conjunction with Mars twice, on the 3rd-4th and on the 31st of December.

Jupiter moves into the morning sky on December 1st, conjunction with the sun occurring on that date.

Saturn reaches a stationary point among the stars on December 5th and begins retrograde motion. It is in Leo, 6° west of Regulus and nearly a magnitude brighter than that star. With a telescope, Saturn's rings appear 13° open, halfway closed from the maximum inclination to the ecliptic. The diameter of the rings is 44″ (greater axis), and the shadow of the rings may be seen on the disk of the planet.

Uranus on December 16th is at opposition, hence it will be visible practically all night this month. On the 16th, the planet will be in conjunction with Zeta Tauri, Uranus 1° 21′ north. The planet will be scarcely visible to the unaided eye, at magnitude +5.8.

Neptune may be found with telescopic aid after midnight, in Virgo near the star Gamma. The position on the 15th is R.A. 12^h $49^m.2$, and Dec. —3° 38′ (1947).

EDWARD ORAVEC

DECEMBER METEORS

The Geminid meteor shower, second in richness to the Perseids, may favorably be observed this month. Maximum comes on December 11th and 12th, when the moon is new, and rates up to 30 meteors per hour may be expected. Under ideal conditions, 60 meteors and more per hour have been recorded. Geminids are of medium speed and bright meteors are often seen. Unlike other bright showers, the Geminids are best seen in the evening hours before midnight. The radiant is located near the star Castor, and will be in the eastern sky all evening. E. O.

PHASES OF THE MOON

Last quarter	December 5, 0:55
New moon	December 12, 12:53
First quarter	December 20, 17:43
Full moon	December 27, 20:27
Last quarter	January 3, 11:13

VARIABLE STAR MAXIMA

December 1, T Cassiopeiae, 7.8, 001755; 1, RV Centauri, 7.6, 1331**55**; 3, RU Sagittarii, 7.2, 1951**42**; 8, RV Sagittarii, 7.8, 1821**33**; 9, R Horologii, 6.0, 0250**50**; 10, S Sculptoris, 6.8, 0010**32**; 10, R Andromedae, 7.0, 001838; 10, RS Librae, 7.7, 1518**22**; 29, S Carinae, 5.7, 1006**61**; 30, S Canis Minoris, 7.5, 072708.

These predictions of variable star maxima are made by Leon Campbell, recorder of the AAVSO, Harvard College Observatory, Cambridge 38, Mass. Serious-minded observers interested in making regular telescopic observations of variable stars may write to Mr. Campbell for further information.

Only stars are included here whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

DEEP-SKY WONDERS

NGC 650, M76, $1^h\ 36^m$, $+51°\ 4'$, an irregular, large planetary closely north of Phi Persei, with its brighter portions measuring 87″ x 42″; in a small telescope it may look like two objects as it did to the elder Herschel. H and Chi Persei, the famous double galactic cluster, $2^h\ 15^m$, $+56°\ 40'$. Probably the best "show" object of its type as it lies far from the ecliptic and is less bothered by moonlight than most clusters. The infinite richness of the field makes it a beautiful sight in everything from field glasses to quite fair-sized telescopes. Mythologically this group is the diamond hilt of the sword of Perseus.

NGC 1039, M34, $2^h\ 35^m$, $+42°\ 18'$, a loose galactic cluster between Algol and Gamma Andromedae which medium-sized amateur telescopes will resolve into the individual stars, although Messier saw it as a hazy patch. However, it also needs perfect moonless nights to reveal its true beauty and interest.

WALTER SCOTT HOUSTON

STARS FOR DECEMBER

from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

Chart correction: Beta and Gamma Lyrae should be reversed.